

ABSTRACTS PRESENTED AT THE ANNUAL MEETING

BOTANY SECTION

EDWARD W. CHESTER, *Chairman*

Further Studies on the Effects of Mammalian Carcinogens on Cinnamon Fern Leaf Development. JAMES D. CAPONETTI, University of Tennessee.

Cinnamon fern leaf primordia cultured in vitro offer a system for evaluating the effects of mammalian carcinogens and other chemical compounds on the growth and development of leaves. Representatives of several groups of mammalian carcinogens and related compounds have been tested for their effects on the development of cinnamon fern leaves in sterile culture. The results thus far have shown that a nitrosamine and four benzo (a) pyrenes inhibit the growth of the leaves when compared with controls. An aflatoxin and a benz (a) anthracene stimulate the growth. Mature leaves are taller than controls and bear more leaflet pairs. Another benz (a) anthracene and a carcinogen promotor have no differential effect on the leaves; growth is similar to controls. In those instances where leaves reached cultural maturity, differentiation of leaf parts appeared to proceed normally as in controls. In no case did leaves produce callus tissues or tumorous growths.

Reversal of IAA and GA Induced Pea Epicotyl Elongation by Alternate Electron Transport Inhibitors and Concanavalin A. W. H. ATKINSON AND B. P. STONE, Austin Peay State University.

A study was conducted to determine the roles of alternate electron transport and cell membrane receptors in hormone induced epicotyl elongation of *Pisum sativum* variety "Little Marvel". An inhibitor of the electron transport system, 8-hydroxyquinoline, was effective in blocking epicotyl elongation in tissue treated with indoleacetic acid and gibberellic acid. Elongation was not reinstated upon addition of ATP. The lectin concanavalin A was also effective in inhibiting the hormone induced elongation. This inhibition could be reversed by the addition of mannose. These data suggest that both the alternate electron transport system and cell membrane receptors are involved in hormone induced elongation of epicotyl sections.

Light Quality in Relation to Expansion of Avena Coleoptiles and Coleoptile Segments. FREDERICK T. WOLF, Vanderbilt University.

Growth in length of coleoptiles of intact *Avena* seedlings, of decapitated coleoptile segments, and of apical coleoptile segments which included the tip was compared in equal intensities of various wavelengths of light with that which occurred in darkness. Light has no effect on the growth of decapitated segments, which was comparable to that in darkness in all instances. Growth of apical segments including the coleoptile tip is inhibited at 510-565 nm and stimulated at 605-700 nm. Growth of coleoptiles of intact seedlings is inhibited by light at 455-565 and at 660-700 nm, though not at intermediate wavelengths. Possible interpretations of these different responses will be discussed.

Carbohydrate Inhibition of Pigment Formation in a Pigmented, Asporogenous Mutant of Bacillus cereus. THEODORE E. SNAZELLE, The University of Tennessee at Nashville and DAVID W. COOK, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Production of large, orange-pigmented colonies of *Bacillus cereus* (GCRL-29) on Difco Marine Agar 2216 (contains no carbohydrate) is inhibited by the incorporation of 0.5% glucose (5 g/liter) to 1% glucose (10 g/liter) or 1% mannose into this medium resulting in the formation of small, white colonies. When the Difco medium is supplemented with 1% arabinose or 1% raffinose, *B. cereus* causes the formation of medium-sized, pale orange-pigmented colonies with arabinose or large, orange-pigmented colonies with raffinose. Production of orange pigment by *B. cereus* is seemingly related to the utilization of protein as a carbon source rather than a carbohydrate. Thus, if a carbohydrate is utilized by *B. cereus*, orange pigment will not be produced.

Isozymes as Taxonomic Indicators of Polyporaceae (Basidiomycetes). JOHN W. HARRIS, S. K. BALLAL, AND FRANK P. SANDERS, JR., Tennessee Technological University.

In recent years, electrophoretic banding patterns of isozymes have been utilized to supplement conventional criteria for characterizing certain fungal taxa. Previous work in this laboratory has suggested that such patterns provide useful information about taxonomic relationships between isolates of species belonging to the family Polyporaceae. In the present study, mycelial extracts of two isolates of one species of *Fomitopsis* and four isolates of two species of *Fomes* were subjected to polyacrylamide gel electrophoresis. The results were analyzed by computer, using a hypergeometric distribution model, in order to compare the banding patterns of the different isolates. The results substantiate our previous conclusions regarding the usefulness of these procedures for clarifying relationships between fungal taxa.

Somatic Mutation Induction in Tradescantia. P. S. KAHLON, Tennessee State University.

Tradescantia clone 4430 heterozygous for flower color was used as a test system to induce mutations with ethyl methane sulfonate (EMS). The objective was to determine the effect of pH, Concentration of mutagen and duration of treatment on the frequency of mutations. The Stamen hairs were analyzed for: (1) pink events thought to be due to a point mutation or segmental deletion, (2) non pigmented cells, (3) dwarf cells and (4) giant cells.

Branches from potted plants ready to bloom or having 1 or 2 flowers open, were cut close to the ground. These cuttings were placed in EMS solutions prepared in 0:1 molar phosphate buffer and constantly aerated during this time. After the exposure, the cuttings were rinsed with sodium thiosulfate to remove unreacted mutagen. The cuttings were then grown in beakers containing nutrient solutions. The stamen hairs from these cuttings were analyzed for mutation frequency. The data indicate that the number of flowers is reduced. (Supported by CSRS grant no. TENX-PR-0007-35884)

Fossil Flora of the Friar Branch and Boyd Buchanan School Sites. H. R. DESELM, The University of Tennessee, Knoxville and J. L. BROWN, The University of Tennessee, Chattanooga.

Excavations for the construction of Friar Branch Lift Station, Contract 47A of the City of Chattanooga's Interceptor Sewer Program, and for interceptor sewer lines near Boyd Buchanan School revealed the existence of an organic deposit below a 14-foot depth along South Chickamauga Creek at Chattanooga, Hamilton County, Tennessee. Logs were dated at 10,270, 9,515, 4,475, and 4,465 years (before 1950), at a time when late Paleo-Indian and subsequently Archaic peoples could have occupied the area. The flora of the deposit was examined, and leaves, fruit, seed, wood, and thorns were used to determine the 32-plant taxa found. The flora approximates one which would be found today in similar sites, suggesting that the climates of that time were not greatly different from those of today.

Indirect Ordination of Forest Stands of the Northwest Highland Rim. RICHARD J. JENSEN, Wright State University.

Twenty-eight forest stands in Montgomery and Stewart Counties, Tennessee were sampled using a modified random-pairs method. The data were analyzed by reciprocal averaging, an analog of principal component analysis. Forty tree species were used as the basis for ordinating the stands. Tree species included those that a) occurred in at least four stands and/or b) had a frequency of 10% or higher in at least two stands. Ordinations were prepared with two data sets: one with the species coded present/absent and the second with species coded by their frequency values. The reliability of reciprocal averaging is indicated by the two ordinations being virtually identical, both for species and stand ordinations. The first factor extracted apparently reflects moisture and slope conditions while the second seems to reflect soil conditions. Results presented are compatible with

earlier subjective evaluations of stand relationships, although distinct differences are noted.

Dry Phase Vegetation of the Uplands of the Cumberland Plateau of Tennessee. GARY L. WADE AND H. R. DESELM, The University of Tennessee.

A study with the objectives of classifying the vegetation types of the rolling surface of the Cumberland Plateau and relating them ecologically to soil and site factors was carried out during the summer of 1976.

One hundred and eighteen 1/10 ac (1/25 ha) plots were selected from ridge top, upper slope, and cliff edge positions. From these, nine community types were defined for the dry upland surface of the Plateau based on species composition. The white oak, chestnut oak, and blackjack oak community types are believed to be stable. The shortleaf pine, post oak, black oak, scarlet oak, and mixed pine-oak community types are successional. The Virginia pine community type is believed to be stable or successional, depending on local site conditions.

An Ecological Survey of Dick Cove, Sewanee, Tennessee. ROSS HINKLE, PAUL SCHMALZER AND H. R. DESELM, The University of Tennessee.

Dick Cove, which is at the western edge of the Cumberland Plateau on the campus of the University of the South, supports one of the best examples of old growth forest extant on the Cumberland Plateau in Tennessee. As part of an ongoing study of the vegetation of the Cumberland Plateau in Tennessee, Dick Cove was examined during the summer of 1977.

Fifty-three 1/10 ac (1/25 ha) circular plots were placed in the stand using a stratified random sampling scheme. The importance values of 23 canopy species were submitted by sample to an agglomerative clustering technique which yielded seven community types. Use of canonical analysis to establish the distinctness of the communities revealed that four (Chestnut Oak, Tilia-Sugar Maple, Chestnut Oak-White Oak-Northern Red Oak and Northern Red Oak-Shagbark Hickory) are distinct and three (Sugar Maple-Northern Red Oak, Sugar Maple-White Oak and White Oak-Tulip-Northern Red Oak) are much less so.

The richest community, Sugar Maple-Northern Red Oak is similar to Braun's (1950) Mixed Mesophytic types of the Cliff Section of the Cumberland Plateau (Jaccard's Index = 59%) and to the All Deciduous Mixed Mesophytic type of southeastern Kentucky (51%).

Indirect gradient analysis (Reciprocal Averaging) suggests that segregation of the communities on the landscape may be related to moisture or pH/nutrient gradients.

*The Status of *Gymnocladus dioica* (L.) K. Koch in Tennessee.* EDWARD W. CHESTER, Austin Peay State University.

Gymnocladus is a genus of two species, one in eastern North America and one in eastern Asia (China). Fossil representatives, of Miocene age, are found in eastern Asia and northwestern United States. The Kentucky Coffee Tree is found in North America from extreme southern Ontario, New York to South Dakota, and southward to Tennessee, Missouri, and Oklahoma. The Tennessee distribution is over the state but the species is rare in most areas. It appears to be most abundant in extreme west Tennessee and in limestone areas of middle countries. The only known population from the western Highland Rim has been investigated and found to be part of a bottomland community dominated by *Celtis occidentalis*, *Acer negundo*, and *Acer saccharinum*.

CHEMISTRY SECTION

ROBERT G. ZIEGLER, *Chairman*

The Application of Photoelectron Spectroscopy to the Study of Metal Atoms. M. S. BANNA, Vanderbilt University and D. C. FROST, C. A. McDOWELL AND B. WALLBANK, University of British Columbia.

A number of free atom core binding energies have been measured using 1487eV-x-rays in a specially constructed photoelectron spectrometer. The systems studied include zinc, cadmium, sodium and potassium. The various methods of estimating core binding energies are examined in light of our results. Satellite structure observed in some of the core spectra will also be discussed.

A Study of the Weathering and Aging of Plutonium. DAVID T. FARRAR, Tennessee Technological University.

A long-term project of perhaps 20 years duration involving plant uptake of uranium and transuranics is now in its fourth year at the Arid Lands Ecology Reserve (ALE) in Richland, Washington.

During the past two summers, core samples of Pu-contaminated soil have been removed from lysimeters used in the field to grow cheatgrass, barley, and peas. Alpha-counting of the core samples show that the plutonium has moved both up and down the soil column of the lysimeter during the three to four years of field exposure.

The solubility of the plutonium has also been studied, and preliminary results indicate that the solubility is increasing with time.

The results of alpha-counting the harvested plants will be discussed briefly. Also a project initiated this past summer (1977) at ALE involving uptake of technetium by soybeans and wheat will be described.

The Kinetics and Thermodynamics of the Geometrical Isomerization of Tris (Acetylphenylacetyl)tetra-carbonylmanganate Aluminum. C. M. LUKEHART AND G. PAULL TORRENCE, Vanderbilt University.

In a continuing comparative study of the structural similarity of the tris-chelate complexes of aluminum having metallo- β -diketonate ligands to those complexes having β -diketonate ligands, the PMR study of the kinetics and thermodynamics of the *trans-cis* geometrical isomerization of tris(acetylphenylacetyl)tetra-carbonylmanganate aluminum, $Al(abtm)_3$, is reported. The metallo- β -diketonate ligands are metallo analogues to 1-phenylpentane-2,4-dione where the methine group is replaced formally by the $Mn(CO)_2$ moiety. The PMR study was performed in CCl_4 at 16°, 29° and 36° using the methyl resonances of $Al(abtm)_3$ as a probe to the isomerization. The complex crystallized solely as the *trans* isomer and then isomerized to the *cis* isomer with the *trans* isomer being the thermodynamically preferred isomer. The first-order rate constant for this isomerism at 298°K is $0.76 \pm 0.04 \times 10^{-3} \text{ sec}^{-1}$ and the values of the activation parameters are: ΔH^\ddagger , $30.2 \pm 0.8 \text{ kcal/mole}$; ΔS^\ddagger , $28.8 \pm 2.6 \text{ eu}$. The equilibrium constant was determined at four temperatures. The calculated thermodynamic parameters are: ΔH° , $01.81 \pm 0.61 \text{ kcal/mole}$; ΔS° , $-9.04 \pm 2.06 \text{ eu}$. The overall rate constant at 298°K and the values of the activation parameters for this isomerization are very similar to the values reported for the geometrical isomerization of $Al(pmhd)_3$.

The Substitution Chemistry of the Metallo-Acetylacetonate Complex, $[cis-(OC)_2Mn(CH_2CO)_2]_3Al$. KEVIN P. DARST AND C. M. LUKEHART, Vanderbilt University.

The attempted direct substitution of one carbonyl ligand on each manganese atom of the metallo-acetylacetonate complex, $[cis-(OC)_2Mn(CH_2CO)_2]_3Al$, by triphenylphosphine, *o*-phenanthroline, dipyriddy or methyl isocyanide using thermal or photolytic activation led to the degradation of the complex. However, the substituted acetyl complexes, $cis-CH_3C(O)Mn(CO)_4(RNC)$ where R is methyl, cyclohexyl or *t*-butyl, can be prepared from $CH_3Mn(CO)_5$ and the appropriate isocyanide, and when these complexes are treated with one molar equivalent of methyl lithium the substituted metallo- β -diketonate anions, $fac-(OC)_3(RNC)-Mn(CH_2CO)_2^-$, are formed. The reaction was followed by IR, and only the facial isomer was observed. The bis(triphenylphosphine)iminium salt of one of these anions ($R=CH_3$) was isolated. These anions coordinate to $Al(III)$ ion affording the neutral, tris-chelate complexes having the substituted metallo-acetylacetonate ligand. The solution-phase IR and PMR data indicate that the facial orientation of the ligands about the Mn atom is maintained. When R is *t*-butyl, a *cis-trans* isomerization about the Al ion is observed.

The Preparation and Coordination of the Metallo Analogues of Several Triacylmethanide Anions. DAVID T. HOBBS AND C. M. LUKEHART, Vanderbilt University.

The successive nucleophilic addition of two equivalents of a lithium reagent, $R'Li$, to the two carbon monoxide ligands which occupy facial sites of an octahedral acyl complex of the type, $(OC)_3ReC(O)R$, affords a dianionic isoelectronic metallo analogue, $fac-(OC)_3Re(RCO)(R'CO)_2^-$, of the triacylmethanide

anion, $(RCO)(R'CO)_2C^{-}$. These dianions are formed from a stoichiometric amount of the organolithium reagent and represent the formal substitution of the anionic carbon atom of a triacylcarbanion by the transition metal organometallic moiety, $fac-(OC)_3Re^{-}$. These metallo dianions, where R is methyl, benzyl or isopropyl and R' is methyl, act as tridentate, chelating ligands thus forming neutral bis-chelate complexes with Group IVB metals, $[fac-(OC)_3Re(RCO)(R'CO)_2]_2M(IV)$, where M is hafnium or zirconium, and anionic bis-chelate complexes with aluminum(III) ion, $[fac-(OC)_3Re(RCO)(R'CO)_2]_2Al^{-}$. The counter ion for these anionic complexes is either Me_4N^+ or PPN^+ .

The Synthesis and Characterization of Several Metallo- β -Ketoinimine Molecules as the Ketamine Tautomers. C. M. LUKEHART AND JANE V. ZEILE, Vanderbilt University.

When the enol tautomers of the metallo- β -diketonate molecules, $cis-(OC)_3Re[C(CH_3)O \cdots H \cdots OC(R)]$ where R is methyl or iso-propyl, are treated with primary amines, H_2NR' , the complexes, $cis-(OC)_3Re[CH_3C(O)] [CH_3CN(R)(H)]$, are formed. Ten such complexes with R being methyl and four complexes of this type with R being iso-propyl have been isolated. The single-crystal x-ray structure determination of the complex with R and R' being methyl and phenyl, respectively, is reported. This solid-state structural data and the solution-phase structural data obtained from IR and PMR are consistent with the formation of these complexes as metallo analogues to the well-known ketamine tautomers of β -ketoinimine molecules where the methine group is replaced formally by the $Re(CO)_4$ moiety. The enolic nature of these complexes is established by chemical reactivity and spectroscopic data. The various forms of isomerism are discussed, and the preparation of two diimine complexes is presented, also.

Polarographic Detection of an Unsuspected Impurity in Acetamide. ROBERT G. ZIEGLER, Lincoln Memorial University.

An attempt was made to study the interaction of nickel(II) and cobalt(II) ions with acetamide using polarography. When polarograms of nickel sulfate and acetamide were made, two polarographic waves were obtained. When further polarograms were made in order to get additional data and polarograms were made using cobalt chloride and acetamide, no second polarographic wave was found. Investigation revealed that Eastman Kodak acetamide was used to make the first set of polarograms and J. T. Baker acetamide was used to make the second set of polarograms. Polarography of the acetamides revealed that there is a reducible impurity in the Eastman Kodak acetamide which is not in the J. T. Baker acetamide. Identification of this impurity has not yet been successful.

Cooperative Phenomena in Adsorbing Colloid Flotation. DAVID J. WILSON, Vanderbilt University.

Foam flotation of flocs and precipitates is assumed to occur when a condensed monolayer of surfactant forms on the particles, causing them to become hydrophobic and permitting bubble attachment because of a non-zero air-water-solid contact angle. The formation of the condensed surface phase (hemimicelle) is a cooperative phenomenon due to the van de Waals forces between the hydrocarbon chains of the surfactant species. A statistical mechanical method described by Fowler and Guggenheim is used to investigate the effects of temperature, ionic strength, and particle surface potential on this surface condensation. The effect of hemi-micelle formation at the air-water interface on the efficiency of flotation by a coulombic mechanism is also investigated, and the influences of temperature and ionic strength determined.

Pyrolyses of α Alpha, ω Mega-Chlorotrimethylsiloxylalkanes. EUGENE A. KLINE AND HUGH B. PARTIN, Tennessee Technological University.

$Cl(CH_2)_nOH + Me_3SiCl \xrightarrow{NH_3} Me_3SiO(CH_2)_nCl \xrightarrow{A} Me_3SiCl + (CH_2)_n$

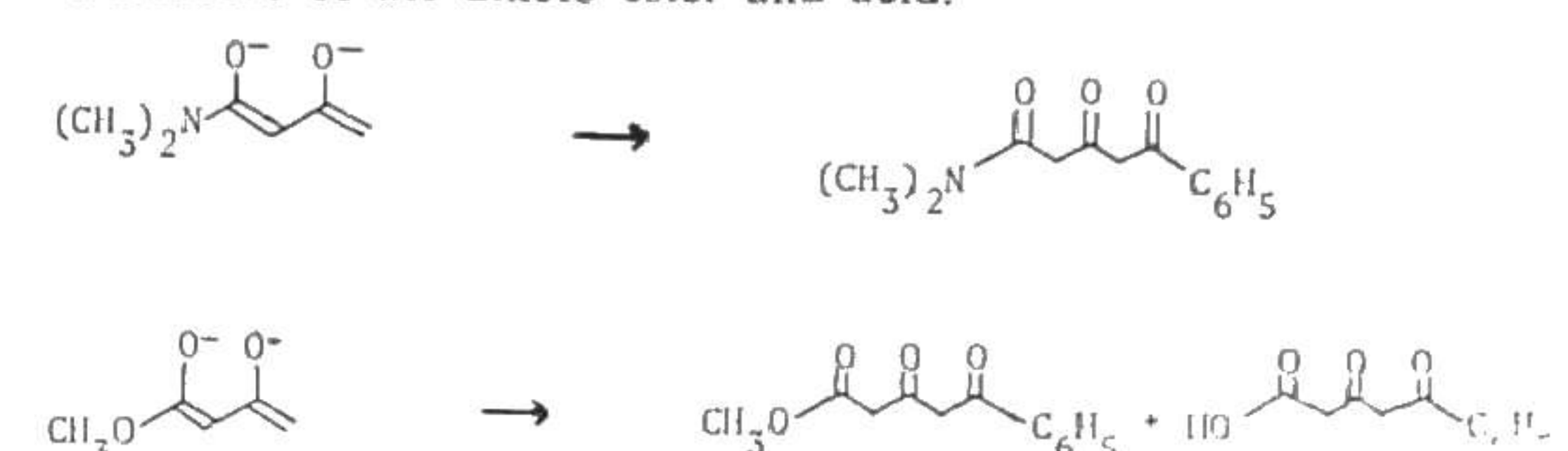
I II III

Chloroalkanol (I $n=2,3,4$) react with trimethylchlorosilane in the presence of ammonia to produce the siloxylchloroalkanes (II), at ice bath temperatures. Upon heating these compounds in sealed tubes to temperatures in the range of 100-300°C similar products of trimethylchlorosilane and the corresponding cyclic

ethers (III) are produced. Yields vary with differences in temperature and chain length. A four center mechanism is proposed.

New Synthons for Polyketides. THOMAS M. HARRIS AND JAMES HUBBARD, Vanderbilt University.

Dianions of ethyl acetoacetate and other β -keto esters have been used extensively to introduce substituents at the γ -position. Limitations of these reactions, particularly in acylation reactions, include (1) thermal instability of the dianions, (2) attack by nucleophilic species on the ester alkyl group, (3) self condensation of β -keto ester dianions with monoanions, and (4) instability of products. With the hope of circumventing some or all of these problems, dianions of *N,N*-dialkyl β -keto amides are being investigated. One example is the condensation of *N,N*-dimethyl acetoacetamide with methyl benzoate to give the diketo amide. The corresponding reaction of methyl acetoacetate gives a mixture of the diketo ester and acid.



Our interest in these intermediates stems from their potential value for preparation of poly β -carbonyl compounds needed for syntheses of polyketide natural products.

Studies on Δ -Amino Levulinic Acid Modification in Alkaline Systems. HUSSAINT SMITH AND HENRY A. MOSES, Meharry Medical College.

A number of recent studies have shown that delta amino levulinic acid (ALA) (an intermediate in the biosynthesis of porphyrins) is unstable in basic medium.

Although no evidence has yet been obtained concerning the mechanism of conversion of the delta amino levulinic acid under basic condition, some suggestions have been made for its conversion to pyrazine derivatives.

Anton Szutka's report discusses the conversion of ALA to pyrrole derivatives by U.V. irradiation. The product of the reaction was found to react with P-dimethyl amino benzaldehyde in acid solution (Ehrlich's reagent) to form a red compound.

This is a report of the partial characterization of the material found from ALA when it is subjected to basic conditions.

The materials obtained from KOH pretreated ALA was purified on alumina column based on the method of Westall. The material eluted with 6% Acetic acid was Ehrlich's reagent positive.

Infra red spectra were run (KBr Pellet) (on Beckman IR-20A). Strong absorption bands were obtained at 3220, 1600 and 1420 and weaker bands at 2930, 1345, 840 and 690. The Spectra of this material is very different from those of pure ALA.

Characterization of CoASPC From Baker's Yeast. J. M. WAKIM, E. T. BUCAVAZ AND R. M. MACLEOD, The University of Tennessee at Martin and The University of Tennessee Center for the Health Sciences.

Bucovaz *et al.* (1977) J. Tenn. Acad. Sci. 52, 27-30 described an assay for the detection of cancer based on an interaction between a protein(s) in the serum of cancer patient and CoA synthesizing protein complex (CoASPC) from Baker's yeast. The present work is a partial characterization of the CoASPC.

CoASPC can be radioactively labeled with ^{14}C -pantothenic acid and/or ^{35}S -L-cysteine. The incorporated label is precipitated with CoASPC in hot trichloroacetic acid. Polyacrylamide gel electrophoresis of labeled CoASPC indicates that radioactivity is present in two components. The two components can also be separated by gel permeation chromatography.

Exposure of the labeled CoASPC to sodium dodecyl sulfate (SDS) causes a shift in the positions as well as in the proportions of the label in the two components. A very small portion of the label is lost when labeled CoASPC is dialyzed against 0.1% SDS for 48 hours. In contrast to the undialyzed sample, electrophoresis of the dialyzed sample shows that all the radioactivity is associated with the small molecular weight component. The molecular weight of the small component is estimated to be 6,000 daltons.

Electrical Aspects of Adsorbing Colloid Flotation. Specific Adsorption of Ions by Flocs. ANN N. CLARKE AND DAVID J. WILSON, Vanderbilt University.

Adsorbing colloid foam flotation is a promising method for quick, efficient removal of low concentrations of toxic heavy metals from wastewaters. The efficiency of flotation and the recovery of surfactant from the sludge in the collapsed foamate are both strongly affected by the extent to which nonsurfactant ions are specifically adsorbed into the primary layer of the floc, which results in large changes in floc zeta potential. We use a non-ideal Gouy-Chapman model with specific adsorption to calculate the adsorption isotherms of specifically adsorbed ions and the zeta and surface potentials of the floc particles. Effects of concentration, ionic charge, ion-floc binding energy, intrinsic surface charge density, and surface binding site density are examined.

ENGINEERING SECTION

DAVID W. YARBROUGH AND RAY KINSLOW, *Cochairmen*

Linear Predictive Processing of Speech with Additive Noise. CHARLES F. MORRIS, Memphis State University.

Linear predictive processing techniques have found very widespread application in speech, processing and communications within the last seven years. Its efficient parameterization of speech provides a useful basis for speaker and speech recognition systems and for low data rate voice transmission. It can also be used for reconstructing a noise-free version of speech originating in a noisy environment. It is this last application that we are researching at Memphis State.

Although linear prediction is quite robust, it suffers serious degradations when noise is present in the speech to be processed. However, just how noise affects the process is only recently beginning to be studied.

This paper will first present a brief description of the linear predictive technique, then it will deal with some of the ways additive noise affects it. Specifically, a quantitative analysis is presented of the effects of various levels of noise on the linear prediction coefficients, the derived vocal tract formant frequencies and bandwidths (poles), and the linear prediction residual. The paper will conclude with a discussion of the direction our research is taking.

Redistribution of Ion Implanted Boron in Silicon During Annealing. DAVID W. YARBROUGH, Tennessee Technological University.

Experimental concentration profiles for "B" implanted in one ohm-cm Si are compared with profiles computed using LSS theory. Data for boron implants of 1.E13, 1.E15 and 5.E15 atoms/cm² and implant voltages of 50, 70 and 100 keV were analyzed. The analysis showed that agreement between experimental and theory improves with increased boron dose and implant voltage. Redistribution of implanted boron with annealing for 30 minutes at 1273 K show a diffusion coefficient enhancement factor of five at the lowest implant dose studied. The enhancement of the boron diffusion coefficient increased with silicon crystal implant damage.

Increased Melting Rate Due to Convection in the Liquid. EDWIN I. GRIGGS, Tennessee Technological University.

An attractive means of thermal energy storage involves use of the heat of fusion associated with a solid-liquid phase change. Significantly more energy per unit volume can be stored via a phase change than can be stored via sensible storage unless undesirably large temperatures are used in the latter. In the design of phase-change storage systems, there is a need for accurately predicting the heat transfer rates within the storage medium.

A study has been performed on the heat transfer rates within the paraffin, nonadecane. A one-dimensional computer model was developed for predicting conduction heat transfer. When melting occurs with the heated surface located on the bottom of a storage unit, convective currents develop within the liquid layer and these currents markedly increase the heat transfer rate. Because of the formidable nature of accurately analyzing these convective currents, an approximate analysis has been performed

using the conduction model. Convective effects were artificially included by altering the thermal conductivity of the liquid. This alteration was made using some published correlations for steady-state convective heat transfer between two horizontal surfaces. Comparisons have been made between the predicted rates using this modified conduction model and experimentally measured rates. The approach appears satisfactory for predicting melting rates, but it fails to predict meaningful temperature distributions within the liquid.

Slope Stability Analysis of Landslides Associated with Surface Coal Mining. JAMES D. COWAN, West Coal Company and B. DAN MARKS, The University of Tennessee.

The stability of overburden waste fill slopes has long been a problem in the contour mining procedure of surface coal mining utilized in the mountainous Appalachian region. Many procedures have been developed in geotechnical engineering to predict the stability of slopes in civil engineering works.

The purpose of this study was to select a method of slope stability analysis applicable to the analysis of overburden waste fill slopes in surface coal mining operations, and to investigate existing landslides by the selected analysis procedure.

Using Bishop's Simplified Method of Slides and soil parameters determined by laboratory triaxial and direct shear strength tests, three existing landslides were analyzed to establish the reliability of the analysis procedure in predicting slope failures. After establishing the reliability of the analysis procedure, alternate cross sections were analyzed to evaluate surface mining fill bench regulations, and to determine the effects of various factors on stability of large overburden waste fills.

The investigation revealed that cross sections other than those currently specified by Tennessee Surface Mine Regulations could produce higher factors of safety while possibly reducing coal production costs. It was also determined that for large overburden waste fills two potential failure surfaces exist with nearly equal factors of safety. Those two failure surfaces correspond to: 1) the interface between the fill and natural colluvium overburden; and 2) the interface between the colluvium overburden and intact rock. Failure surface, were found to be controlled by the relative strength differences of the waste fill material and the colluvium, and by the size of the fill. The colluvium-rock potential failure plane controlled for most large fills investigated.

The Effects of Channelization on the Waste Assimilative Capacity of Small Streams. EDWARD CHARLES DAVIS, Vanderbilt University.

Stream channelization, which consists of deepening, widening, straightening, clearing or lining the existing channels of rivers and streams, is an engineering technique used to control floods, drain wetlands, improve navigation or control erosion. It is the purpose of this paper to investigate the effects of channelization on the waste assimilative capacity of small, west Tennessee streams, and to try and predict what changes will occur in dissolved oxygen, biochemical oxygen demand, nitrogen, and phosphorus concentrations after channelization has been completed.

The mathematical model used to monitor these parameters is PIONEER-I, a steady state water quality model developed by Battelle Northwest Laboratories. Changes in stream slope, bottom vegetation, channel shape, and Manning's n, as well as other important factors are investigated before and after stream channelization, and the computer model is used to predict the resulting water quality changes.

Results show that the hydraulic effects of the improved channel allow the stream to assimilate approximately three times the wasteload by increasing the velocity, lowering the depth of flow, and moving the oxygen sag point farther downstream and spreading it out over a longer stream section. The inorganic nitrogen and phosphorus, which enters the stream in the wastewater, can no longer be utilized by the rooted aquatic vegetation, and their presence is observed farther downstream where they are converted to organic forms by existing phytoplankton. This stream modeling effort concludes that the channelization of a small stream for flood control purposes has a significant effect on its waste assimilative capacity. Altered hydraulic parameters, which tend to raise the reaeration rates, as well as physical changes, such as removal of benthic deposits, aid in allowing a

greater amount of carbonaceous matter to be assimilated.

Soil Stabilization Potential of Portland Cement Stack Dust. JO K. HOUSE, Tennessee Department of Transportation and B. DAN MARKS, The University of Tennessee.

During the production of portland cement, a fine material designated as stack dust is collected throughout the manufacturing process. Some of the stack dust is returned to the production process, however, generation of such large quantities of the material renders complete utilization impossible. Excessive quantities of the stack dust must be stockpiled or disposed of by special procedures.

The purpose of this study was to investigate the feasibility of utilizing stack dust as a soil stabilization additive. A laboratory testing program was developed to determine the effect of varying percentages of stack dust upon two distinctively different soil types.

Atterberg limits, moisture-density relationships and unconfined compressive strengths were utilized in the study to evaluate the stabilization potential of the stack dust.

Evaluation of the test results obtained throughout the study indicated that the stack dust influenced physical and engineering properties in a similar manner to that of portland cement.

One-Dimensional Wave Propagation in Viscoelastic Laminates. GEORGE R. BUCHANAN AND YUN-KUANG FU, Tennessee Technological University.

The higher order hyperbolic and trigonometric functions are

$$\text{defined by: } S(m, n; x) = \sum_{k=0}^{\infty} \frac{x^{(km+n)}}{(km+n)!} \quad T(m, n; x) = \sum_{k=0}^{\infty} \frac{x^{(km+n)} (-1)^k}{(km+n)!}$$

where m and n are integers, $0 \leq n < m$.

$$Y = S(m, n; x) \text{ and } y = T(m, n; x) \text{ are solutions of } y^{(m)} = y \text{ and } y^{(m)} = -y$$

respectively, $0 \leq n < m$.

$$S(m, n; x) \text{ and } T(m, n; x) \text{ are each the average of the functions}$$

$\exp(\omega x)$ where the ω 's are the m distinct m'th roots of 1 and -1 respectively.

The series $S(m, n; x)$ and $T(m, n; x)$ can then be summed using

appropriate differentiation formulas.

The equations governing the title problem are derived within the framework of the following assumptions: (1) waves are limited to plane waves in one dimension; (2) the reinforcing laminate is parallel to the propagating wave; (3) the reinforcing material is uniformly distributed; (4) the reinforcing material is linearly elastic and the matrix material is linearly viscoelastic; and (5) the interaction between the solid continuum, matrix, and reinforcing laminates can be represented using the classical mass, spring, and dashpot models shown in Figure 1.

The elastic relation for the reinforcing laminate is

$$\sigma_{r,t} = \alpha_r \epsilon_r + \beta_r \dot{\epsilon}_r \quad (4)$$

The quantities α_m and β_m represent the fractional part of cross-sectional area of each material.

The governing equations and constitutive equations were solved numerically using the method of characteristics. Results for various values of the interaction parameters were obtained for discontinuous stress waves.

Full Scale Lateral Load Tests on Steel Stud-Gypsum Wallboard Partitions. THOMAS S. TARPY, JR. AND STEPHEN F. HAUSTEIN, Vanderbilt University.

For many structural applications steel stud wall panels are perhaps the most economical and most quickly erected system for framing interior and exterior building walls. The shear resistant capabilities of the steel stud wall panels can also be of tremendous advantage to the structural engineer in designing buildings to resist forces caused by wind, seismic action and other lateral loads. However, these panels have primarily been used as elements of enclosure with the walls designed only for the transfer of the corresponding normal components of surface loads into the structural framework. As such, the shear resistance of the panels is not utilized. This is due primarily to the lack of design

information on shear resistance capabilities and maximum panel deformation before failure of the wallboard material. The availability of such information could permit the effective use of wall panels as main shear resisting elements in building design.

The shear resistance and panel deformation are best determined experimentally due to the many material and construction parameters involved. The purpose of this paper is to present the results of a test program under the sponsorship of the American Iron and Steel Institute for obtaining the necessary design information through an extensive full scale research program involving both materials, geometric and connection considerations. The ultimate extension of the test results into the actual design of a building is discussed.

Modern Pile Design Techniques and their Application to the Coastal Plain Soils of West Tennessee. WINSTON B. GAFFRON, JR., Tennessee Department of Transportation and B. DAN MARKS, The University of Tennessee.

The utilization of pile foundations to transmit structural loads to deeper bearing strata has been practiced for centuries; however, only recently have rational pile design procedures reached a usable level of development. Many factors affect pile foundations which make their design complex. Recent research has provided a better understanding of the many factors; however, many of the interrelationships of these factors remain unknown.

The purpose of this study is to provide a better insight into the application of modern pile design techniques as related to actual working situations. To accomplish the objective of this study, load tests conducted by the Tennessee Department of Transportation were analyzed relative to several pile foundation techniques. Pile foundation design techniques analyzed included both static and dynamic procedures.

Evaluation of pile foundation analyses indicated some techniques to be definitely superior to others. Also, the need for large safety factors was denoted. In order to establish more accurate design methods, additional research was shown to be necessary.

Dissolved Oxygen Depletion Mechanisms Operating in the Metalimnion of Center Hill Reservoir. JAMES W. MORRIS AND JOHN A. GORDON, Tennessee Technological University.

The results of an intensive study of the mechanisms of dissolved oxygen depletion in the metalimnion of Center Hill Reservoir during 1977 will be presented. The dissolved oxygen losses will be carefully defined and related to the total bio-community uptake of oxygen in the stratified reservoir. Elements of the bio-community studied include bacteria, phytoplankton, and zooplankton.

The importance of small particle settling dynamics in the changing temperature-density-viscosity regime of the metalimnion will be shown to be a critical part of the oxygen depletion process and the aquatic food chain.

This study involved the use of rather sophisticated and expensive field analytical equipment to measure many of the water quality parameters. This equipment and usage will be described in the paper.

The importance of the results to the understanding of water quality changes occurring in stratified reservoirs, the modeling of these changes, and multipurpose reservoir management will be discussed.

Activated Sludge Treatment of a Municipal Industrial Wastewater. JOHN W. SMITH, Memphis State University and JERRY COLLINS, Tennessee Department of Public Health.

Every municipal waste is characteristically different from any other. These differences are most often due to the waste water contributed by the industries in each municipality. The study which was undertaken dealt with a particular municipal waste made up of domestic and industrial sewage. The specific goals of this study were to determine the unique characteristics of the waste, the effectiveness of activated sludge treatment, and the effects of two particular industrial waste contributors in terms of the overall treatability of the waste water.

This particular waste water, which is generated at a rate of 130 million gallons per day, possessed a larger than expected concentration of organics and solids. Acclimation of a biological system to this waste was found to be very difficult. Organics removal in a bench scale activated sludge system was

much less than desirable. It was observed that when certain industrial wastes were absent from the overall municipal waste, organic removal increased to anticipated levels.

Survey of Rare-Earth Titanium Perovskite-Like Oxides. NEIL L. LOEFFLER, The University of Tennessee Space Institute.

Of all the rare-earth titanium perovskite-like oxides, EuTiO_3 has a cubic perovskite structure. In general the RTiO_3 phases (where $R = \text{La, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu}$) and the solid solutions $\text{La}_{1-x}\text{Gd}_x\text{TiO}_3$ (where $0 \leq x \leq 1$) are best characterized by the space group $D^{19} - P_{6mm}$. The RTiO_3

phases (where $R = \text{La, Pr, Nd, and Sm}$) exhibit no magnetic order. EuTiO_3 is an antiferromagnet. The RTiO_3 phases (where $R = \text{Gd, Dy, Ho, and Er}$) are ferrimagnets. LuTiO_3 is a ferromagnet. The solid solutions $\text{La}_{1-x}\text{Gd}_x\text{TiO}_3$ (where $0 \leq x \leq 1$) exhibit metallic behavior for $x = 0$, n-type semiconductor behavior for $x = .25$, and p-type semiconductor behavior for $x = .75$ and 1.00.

Methan Production from Beef Feedlot Waste. DOUG SHIELDS AND GREG TRAGITT, Tennessee State University.

The biological process of anaerobic fermentation is well known as a method of stabilizing organic sludges from wastewater treatment plants. Methane, commonly known as natural gas, is produced by the anaerobic process. Only recently have investigators viewed anaerobic fermentation as a possible animal waste management alternative. When one views the total animal waste management picture, it makes more sense to design the anaerobic process to maximize gas production benefits and allow waste treatment benefits to be secondary. In order to simulate actual farm conditions, two 2,000-gallon anaerobic digesters have been operated in the field on wastes from a paved beef feedlot. Data on the amount and composition of the gas produced as well as lab analysis of the influent manure and effluent sludge are presented. The variation of gas production with temperature, loading rate, and detention time is examined. Practical information on designing and operating a biogas plant is also included.

Thermal Design of the OC-5 Graphite Irradiation Creep Test Capsule. KENNETH E. EBEL AND HALL C. ROLAND, The University of Tennessee.

Graphite is a very important moderating and structural material in many nuclear reactors. Under stress and irradiation, however, graphite suffers dimensional changes. Knowledge of the way in which these changes occur allows the designer to provide for them and thus form a stable core.

The creep behavior of graphite under stress and irradiation at high temperatures must be known for the design of such reactors as the High Temperature Gas Cooled Reactor (HTGR). A series of experiments is currently in progress to determine this behavior. The OC-5 Capsule is being designed to test graphite at a temperature of 1200 C. The thermal design of this capsule is discussed in detail. It involved several important changes in the basic design of the lower temperature capsules.

In the above thermal analysis of the OC-5 Capsule some questions were raised which led to the decision to mock up the capsule in a simplified bench test using electric heaters. The preliminary design of this bench test is also discussed.

Evaluation of Flat Plate Solar Collectors with Respect to Mass Flow Rate. B. K. PAREKH AND H. C. HEWITT, JR., Tennessee Technological University.

Two identical closed-loop flat plate solar collector systems were designed and fabricated for use in the study of collector efficiency. Theoretical equations governing the collector performance were found in the literature and an experimental study of the effect of mass flow rate and flow passage geometry on collector performance was made. Three different types of collector plate construction (roll bond, serpentine and manifold) were tested with varying mass flow rates through these plates. Theoretical and experimental collector efficiency factors were found to agree within ± 15 percent. The efficiency factor was plotted as a function of the mass flow rate, and an optimal flow rate was determined for each collector geometry. It was found that an approximate value of the effective overall heat transfer coefficient could be determined. The results of this work should aid in designing an efficient flow geometry and a pumping system.

Nonlinear Stress Analysis for a Spinning Disk. RANDALL B. CLARK AND JOHN PEDDIESON, JR. Tennessee Technological University.

Stress analysis is carried out for a homogeneous, isotropic, linearly elastic, rotating disk of inner radius a , outer radius b , density ρ , and modulus of elasticity E , having angular velocity Ω sufficiently large to subject it to large deflections. This is done by solving the equation $(1+\epsilon u')u'' + (1+\epsilon((1-\nu)u'/2 + \nu u'/r))u'/r - (1-\epsilon(1+\nu)u/(2r))u/r^2 = -r(1+\epsilon u/r)$ (1) (where $\epsilon = \rho b^2 \Omega^2 / E$, ϵbu is the radial displacement, br is the radial distance from the center of the disk, ν is Poisson's ratio, and a prime denotes differentiation with respect to r) to find u and then computing the dimensionless radial and circumferential stresses from the respective equations

$$\sigma_{rr} = (1+\epsilon u'/2)u' + \nu(1+\epsilon u/(2r))u/r$$

$$\sigma_{\theta\theta} = (1+\epsilon u/(2r))u/r + \nu(1+\epsilon u'/2)u' \quad (2)$$

$$\text{The boundary conditions employed are}$$

$$u(r_0) = 0, \quad \sigma_{rr}(1) = 0 \quad (3)$$

$$\text{where } r_0 = a/b.$$

Equation (1) is solved by an iterative finite difference method based on the use of three-point central difference quotients to represent the derivatives in (1) and three-point backward difference quotients to represent the derivatives in (3b). It is found that for small values of r_0 (small hub sizes) accurate results cannot be obtained using a constant step size of reasonable magnitude. Rapid changes in the variables occur (in both the linear and nonlinear case) near the hub and variable step sizes with the smallest steps near $r = r_0$ must be used to represent this behavior accurately. This fact should be relevant to the analysis of energy storing flywheels.

The Existence of Multiple Steady States for Laminar, Premixed Flames. R. F. HEINEMANN AND K. A. OVERHOLSER, Vanderbilt University.

Experimental observations of hysteresis phenomena in certain combustion systems have led to speculation that flames may exist in one of several possible configurations for the same feed and burner conditions. In the present work, new computational techniques were used to show that equations describing laminar, premixed flames do indeed have multiple steady-state solutions. The flames were considered to be planar and adiabatic; the Lewis number was assumed to be unity; and the overall chemical reaction rate was assumed to be governed by a single, first-order step. A modification of the Newton-Euler method due to H. B. Keller was used to generate numerical solutions to the conservation equations. In this scheme, the use of arc length as a normalization parameter enables one to avoid numerical problems at singular points. Furthermore, the method identifies and describes solutions bifurcating from the primary solution. Results were expressed in terms of the Euclidian norm of dimensionless flame temperature as a function of dimensionless flame speed. For highly exothermic flames we found three solutions, two stable and one unstable. Flames of lower exothermicity were seen to have a unique steady state. No bifurcated solutions were discovered.

Automated Procedures for Common Cause Failure Analysis of Complex Systems. J. B. FUSSELL, D. P. WAGNER, J. J. ROONEY, J. S. ARENDT, University of Tennessee.

Common cause failure analysis, sometimes called common mode failure analysis, is an integral part of a complete system reliability analysis. A common cause failure results from multiple component failures initiated by the occurrence of a single event or condition. The complexity of many systems encountered in practice, however, renders the existing methods of common cause failure analysis less than adequate.

This paper presents new improvements to a computer aided common cause failure analysis method developed at the University of Tennessee. This synthesis procedure dissects the complex system fault tree, tying the analysis to the subsystem level. Qualitative common cause failure information for the main system failure of interest is synthesized from the results of the individual subsystems. These results are obtained through use of the computer program BACFIRE, also developed at the University.

The automated methods presented here provide a highly organized approach to common cause failure analysis applicable to systems of almost any complexity.

GEOLOGY-GEOGRAPHY SECTION

PHILLIP R. KEMMERLY, *Chairman*

Quantitative Differentiation of the Wilcox and Claiborne Formations in Northwestern Tennessee. ARMIN L. CLARK, Murray State University.

Grain size and heavy mineral analyses of the Wilcox and Claiborne Formations indicate that they are best differentiated mineralogically. Methods of investigation include: grain size analysis of 116 sand samples on a quarter phi interval basis; multivariate discriminant analysis of the textural parameters, mean grain size, sorting, skewness and kurtosis; and statistical analysis of the heavy mineralogy of 52 samples.

The Wilcox and Claiborne Formations are moderately well sorted, fine-grained sands. Multivariate discriminant analysis of the textural parameters indicates the formations cannot be differentiated with a high level of confidence.

Differences in accessory mineralogy permit differentiation of the formations with a high level of confidence. While each formation has the same heavy mineral assemblage, namely ilmenite, leucocene, zircon, kyanite, staurolite, tourmaline and rutile, Wilcox suites contain more ilmenite but less leucocene and zircon than Claiborne suites. Also, beds of "sawdust sand" occur only in the Wilcox Formation.

An Edrioasteroid from the St. Louis Limestone of Montgomery County, Tennessee. RONALD MCCOMB AND JAMES X. CORGAN, Austin Peay State University.

A fairly well preserved echinoderm of the extinct class Edrioasteroidea was collected from the St. Louis Limestone of Montgomery County, Tennessee. This is the first edrioasteroid recorded from Mississippian strata in Tennessee. The oral surface is almost completely exposed, permitting definite placement in the family Agelocritinidae and the genus *Discosystis* Gregory, 1897. In recent studies, *Discosystis* is interpreted as a monotypic genus known from the three well documented and several questionable specimens. Well-known specimens are restricted to the Chesterian series of the Mississippian. The Tennessee specimen occurs in beds of the slightly older Merriamian series. Preservation is not adequate for a species-level characterization.

Fault Block Interpretation of Detailed Gravity Surveys of the Tiptonville Dome. SUSAN K. TOWE, PARRISH N. ERWIN, JR., AND RICHARD G. STEARNS, Vanderbilt University.

The Tiptonville Dome East Scarp is known to be faulted about 15 meters at the surface and a 50 meter fault about 0.3 km east of the scarp offsets Paleozoic rock at a depth of about 0.7 km (density contrast about 0.4 gm/cc). The intermediate structure is unknown. Gravity models are consistent with the surface fault linking with the fault at depth. As modeled, the dome is a horst; the east fault (one of two) is a growth fault with offset of about 10 meters at the surface, about 50 meters at Paleozoic depth (about 0.7 km). Shorter wavelength anomalies cannot be attributed to density contrast at Paleozoic depth, these are near surface features, perhaps grabens or channels, and sand intrusions.

Models of the main anomaly suggest a second fault about 1.8 kilometers east of the scarp. The west side of the main anomaly can be modeled by a third fault approximately 8 kilometers to the west of the scarp with a 60° dip to the west. This is consistent with the Tiptonville Dome being a horst. The east edge (Tiptonville scarp) reflects the main east fault, but the west edge (if it moved in Holocene time) is modified by recent erosion of the Mississippi River.

Lightweight Aggregates Production in Middle Tennessee. LUKE M. SNELL, Law Engineering Testing Company and EDWIN L. HUMAN, Tennlite Inc.

The lightweight aggregates produced in middle Tennessee are commonly used to manufacture lightweight masonry units and structural lightweight concrete. These building materials are specified when reduction in dead weight loads, size reduction in foundations, increased fire resistance, and/or improved insulating values are required.

Lightweight aggregates are produced when a highly siliceous clay or shale, which has bloating characteristics, are heated to

the point of fusion. The bloating characteristics are usually caused by the decomposition of calcite to carbon dioxide at a temperature range from 1600 to 2200F. The evolution of the internal gases at the point of fusion will create a lightweight, hard, vitrified aggregate full of non-connected, cellular voids after the materials are cooled. The manufacturing process is completed by crushing and screening this material to the desired gradation. Production procedures must be controlled so that the lightweight aggregates comply with the "Standard Specification for Lightweight Aggregates for Structural Concrete" (ASTM C-330-77) and/or "Standard Specification for Lightweight Aggregates for Concrete Masonry Units" (ASTM C-331-77).

The lightweight aggregates produced in middle Tennessee have a specific gravity of approximately one-half that of normal weight aggregates. These aggregates will have a 24 hour absorption of below 10%.

Earthquake Risk and the State of Preparedness in the Memphis, Tennessee Area. ROBERT A. MILLER, Tennessee Division of Geology.

Memphis, Tennessee is near the southern end of the high earthquake risk zone in the northern part of the Mississippi Embayment, and extension of the Gulf Coastal Plain. Earthquakes are generated along deep seated faults beneath the embayment.

In 1811-12 a series of violent earthquakes with the epicentral area in southeast Missouri shook the region. Each of the three largest of several hundred shocks felt between December, 1811 and March, 1812, was estimated to have had an epicentral intensity of XII. Many earthquakes have been noted or recorded in this area since 1699.

The Mississippi-Arkansas-Tennessee Council of Governments contracted for a comprehensive study of the earthquake risk in the Memphis area in 1974. This report indicated a 5% probability of a catastrophic earthquake within any given 50 year interval. The study shows that injury, loss of life, and property damage would be great in the event of a major earthquake in that region.

At present Memphis has no building codes or zoning regulations designed to alleviate earthquake damage. No changes in codes or zoning are presently being drafted, and no plans are underway to modify existing structures to reduce potential damage. These decisions appear to be based upon the low statistical odds of a severely damaging earthquake within the projected lifetimes of new structures. Earthquake insurance is available in the Memphis area at rates of 10% to 20% of those in California, but such coverage is not widely in effect there.

Improvement of Earth Resistivity Soundings by Small Auger Samples and Cross Soundings in the Reelfoot Lake Area. JAU-PING TSAU, RICHARD G. STEARNS AND ROBERT G. PERRY, Vanderbilt University.

Recognition and avoidance of lateral discontinuities is essential for accurate sounding interpretation, particularly in a faulted and channelled area. Also interpretation of resistivity and thickness of deeper layers should be improved by direct measurement of the surface layer by drilling. In the Reelfoot Lake study area it appears that a preliminary short cross sounding, if taken near a discontinuity, will show significant differences in apparent resistivity for several same short electrode spacings. It is only when cross soundings agree with each other, and further when a theoretical spacing vs. apparent resistivity curve constructed from small auger samples approximately agrees with the surface sounding curve that we can confidently interpret thickness and resistivity of layers beyond the reach of the drill. When cross soundings do not agree we should not waste time and effort in drilling.

Cases studied to date suggest that improvement in information can allow us to avoid sounding sites where surface sounding interpretations result in errors over 100% (e.g. estimating a layer to be 5 feet thick when it is actually 10 or more feet thick), and the precision gained by sampling the surface layer can add significant accuracy to interpretation of deeper layers at satisfactory sites.

Pond Creek Pleistocene Fossil Sites, Cheatham County, Tennessee. TIMOTHY M. BAGGETT AND JAMES X. CORGAN, Austin Peay State University.

In March 1977 a well preserved mastodon molar was discovered in Pond Creek, Cheatham County, Tennessee. There are no prior unquestioned records of Pleistocene (Wisconsin) vertebrates from the Northwest Highland Rim. At the discovery site, Pond Creek has steep banks that expose 10 feet of poorly bedded gravels with minor beds of well indurated clay. Preservation of the tooth suggests clay covering and little exposure to transportation. It is not possible to identify the stratum from which the tooth came. Plaque deposits on the tooth are now under study and may yield a flora of spores and pollen.

About 120 feet downstream from the mastodon site, an 8" clay bed crops out in a wide band across the creek. It yields abundant plant remains including many deciduous leaves, one nut, needle-like bodies, and scores of small wood fragments. This is the seventh fossil plant locality in Tennessee that is definitely of the Pleistocene age. Megafossils are poorly preserved. Spores and pollen are now under study by Mrs. Hazel R. Delcourt of the University of Minnesota.

Some Observations on "Alluvial" Fans in the Southern Appalachians. HUGH H. MILLS, Tennessee Technological University.

Landforms similar in geometry to alluvial fans are common in the Southern Appalachians, but consist mainly of material more closely resembling colluvium than alluvium. Both solifluction and debris-flow origins have been suggested for these deposits; unfortunately, deciding between these two origins on the basis of sedimentary features alone appears to be difficult.

Two or more ages of fans exist at many locations. Younger fan segments tend to be inset within older fan segments, both on a large and small scale. Boulders are more common on the surface of younger fan segments, and deep weathering profiles have developed on the surface of older segments. These profiles imply that periods of fan aggradation alternate with long periods of surface stability. Elsewhere, such an alternation has been associated with alternation between glacial and interglacial climates during the Pleistocene. However, some workers think the fans unrelated to climate, attributing them instead to rare, catastrophic rainfalls that set off debris flows on the slopes above the fans.

It may be possible to choose between these two hypotheses by establishing the degree of synchronism between fan deposits over a wide region, as climatically induced instability should be geographically widespread and restricted in time, whereas catastrophic rainfalls should be confined to relatively small areas and limited to no particular time interval. In the absence of radiocarbon dates, relative-age criteria are being used in an attempt to correlate deposits between fans. Such criteria include semi-quantitative measurements of clast weathering and soil-profile development.

Shallow Site Exploration with a Drilling Recorder and a Rock Percussion Drill. H. R. BEAVER, Beaver Engineering, Inc.

With the use of a special drilling recorder developed within the last 3 years it has become possible to greatly increase the knowledge of rock strength and weathering patterns.

At a site in Middle Tennessee the Carters Limestone Formation was evaluated using this technique. A proposed high rise apartment complex was to be built there, but the complexity of rock weathering patterns and existence of the T₂ bentonite clay layer required the shifting of the proposed building location to a higher elevation on the site.

In the Oak Ridge, Tennessee area a subsurface investigation found bedrock to be badly weathered and dipping steeply. Based on further studies the site became useable, once unweathered bedrock was found.

At the site of a proposed office building to be built in Nashville it was known in advance of design by the architects that a complex bedrock weathering pattern could be expected. Exploratory holes were drilled at each proposed building column so that precise pre-construction cost estimates could be made.

Improvement of Earth Resistivity Soundings by Small Auger Samples and Cross Soundings in the Reelfoot Lake Area. JAU-PING TSAU, RICHARD G. STEARNS AND ROBERT G. PERRY, Vanderbilt University.

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Engineering Geophysical Logging. J. W. WRIGHT, Tennessee Valley Authority.

Geophysical well logging, originally developed by the oil industry, is a method that utilizes various probes lowered into a borehole to measure physical characteristics of subsurface rocks. Tennessee Valley Authority uses standard logs—sonics, mechanical caliper, natural gamma ray, and gamma-gamma (density)—to determine engineering parameters for foundation investigations. Use of geophysical logging has greatly expanded TVA's data acquisition and is also one of several procedures that has resulted in substantial savings in time and money. Percussion drilling instead of core drilling is another significant advance. The sonic cross hole technique has been improved to extend its distance capabilities for interpretation between more widely spaced holes.

MATHEMATICS SECTION

DONALD C. RAMSEY, *Chairman*

Developmental Studies Mathematics At Chattanooga State Technical Community College. HERBERT L. HOPPER, JR., Chattanooga State Technical Community College.

A significant number of students enter many colleges and universities each year with an inadequate mathematics preparation for their first-level college mathematics course. Chattanooga State is attempting to provide a developmental mathematics program that will enable students to complete the necessary preparation for entrance into their first college mathematics course.

The program includes two sequential courses. The first course is called Basic Mathematics. This course includes arithmetic, simple equations, and percentage. The material for the course was developed by the State Community College System in New York. It is presented primarily by slide-tapes and video-tapes. The course is self-paced.

The second course is called Elementary Algebra. It covers many of the topics found in a first year algebra course in high school. This course is offered by both the lecture-discussion method and by the audio-tutorial, self-paced method.

An in-house placement test in mathematics, diagnostic testing, a mathematics laboratory, a mathematics technician, and student tutors are all an integral part of the developmental studies mathematics program. The mathematics program is one component of a program which, also, includes both developmental reading and developmental English.

On Groups of Order 16. JOHN KINLOCH, East Tennessee State University.

The purpose of this paper is to derive the number and type of distinct abstract groups of order 16. The original investigation of these and other finite groups of different order occupied a good part of the time of group theorists during the 1890's, and their results may be found in the journals of that period. However, the terminology and methods of that period make following the details of those investigations quite difficult for the average modern neophyte of group theory. For that and other reasons it is felt to be instructive to re-derive the above cited results using nothing more advanced than the basic group theory in Herstein's "Topics in Algebra."

An Applied MS-Mathematics Approach. LELAND L. LONG, Tennessee Technological University.

Attention is given to the evolutionary process involved in the construction of an application oriented MS-Mathematics program at TTU. The program structure is designed to allow selection of a non-thesis option. The primary goal of the program is to better train graduate students for industrial and government service positions.

An Oscillation Theorem For A Second Order Linear Differential Equation With Delay. V. M. SAKHARE, East Tennessee State University.

The paper presents a criterion for oscillation of delay equations of the form $y''(t) + p(t)F(y(g(t))) = 0$ and functional delay equations $y''(t) + p(t)F(y_t) = 0$.

Sampling Proportional to Random Size: The Exponential Case. V. R. R. UPPULURI, Oak Ridge Computer Sciences and S. A. PATIL, Tennessee Technological University.

In 1976, E. Barouch and G. M. Kaufman suggested a model, based on sampling proportional to random size, in order to estimate recoverable oil resources. In this paper, we formulate this model in more explicit terms, and obtain analytically trackable forms for the case of an exponential distribution. Specifically we obtain the probability density function of the output at the n^{th} discovery and give analytical expressions for the moments of this variable. This probability density function is useful to find the probability of observing a resource larger than a given quantity at a particular discovery. The mean and variance are in agreement with the results given by Barouch and Kaufman [paper to appear in the book: *Mathematical Aspects of Production and Distribution of Energy*, edited by Peter D. Lax, American Mathematical Society (1977), Vol. 21 of the Proceedings of Symposia in Applied Mathematics].

Computer Simulation of Atmospheric Transport of Emissions from Coal-Fired Power Plants. RICHARD J. RARIDON, Oak Ridge Computer Sciences.

An atmospheric transport model has been used to simulate the depositions and air concentrations of effluents from coal-fired power plants. The model, based on a Gaussian plume formulation, uses meteorological data, together with source characteristics, to compute values for sulfur dioxide and fly ash at distances up to 50 km. Examples are given for several localities.

Continuous Lattices. J. W. LEA, JR., Middle Tennessee State University.

The purpose of this report is to survey the connections between continuous lattices and topological semilattices. In addition we shall briefly indicate recent applications of continuous lattices.

Eudoxus Ladders. JAMES RIDENHOUR, Austin Peay State University.

Eudoxus, an ancient Greek mathematician, devised a clever device for approximating $\sqrt{2}$ by use of a ladder whose rungs consist of pairs of numbers having the property that their quotients approach $\sqrt{2}$ as one proceeds down the ladder. Modifications of this ladder are made in such a manner as to approximate \sqrt{n} for any positive integer n and the relations of certain of these ladders to continued fractions is discussed. Also, generating functions are given for the sequences of numbers appearing on the successive rungs of these ladders.

MEDICAL SCIENCES SECTION

B. R. JENNINGS, *Chairman*

Cadmium and Hypertension. HUBERT L. WALKER, Fisk University and HENRY A. MOSES, Meharry Medical College.

The metabolism of cadmium has become of primary interest in recent years, especially since its presence as an environmental toxic agent has been associated with hypertension in suspecting human population groups. Efforts to determine the mechanism of cadmium induced or associated hypertension have been undertaken in this laboratory. Sprague-Dawley rats fed laboratory chow and given cadmium nitrate solutions *ad libitum* were the experimental animals used. Systolic pressure was monitored weekly and weights were recorded. When the animals were sacrificed, lead and cadmium were determined in selected tissues

using on ESA Model 3010 Trace Metal Analyzer. After thirty six weeks on the experimental regime, the Cd treated animals had slightly higher systolic pressures than the control group. As the dosage of Cd administered increased, so did the parts per million found in the kidney. Also as the kidney Cd increased, the amount of Pb decreased.

While the liver Cd increased slightly, the liver lead remained the same. This difference between kidney Pb and liver Pb can most likely be attributed to different binding proteins. Our data or blood pressures indicated that hypertension had been induced in the animals. These studies along with that of others suggest that a critical threshold level of toxicity exists for Cd. Above the preventive level of Cd induced toxicity, the additional Cd appears to be a critical factor in physiological changes and renal damage, causing elevated blood pressures.

At present these studies are still in progress and even though the strongest evidence linking Cd with hypertension comes from animal studies, there are data suggesting that renal Cd concentrations are abnormally high in hypertensive human beings.

Neutron Irradiation of Rat Embryos In Utero. H. H. VOGEL, JR., The University of Tennessee Center for the Health Sciences.

In the rat, radiation produces congenital anomalies during the organ-forming period (days 9-13), equivalent to the 14th-50th days of human pregnancy. We have exposed, female, Sprague-Dawley rats, on the 18th day of pregnancy, to single, whole-body doses of fission neutrons (20 to 150 rads). The pregnancies were timed at the Comparative Animal Research Laboratory (CARL) at Oak Ridge. The animals were exposed at the Health Physics Division's DOSAR Reactor at Oak Ridge National Laboratory. After 20 rads, there was a small decrease in body weight which lasted from birth to weaning. After 50 rads, 65/275 (23.6%) of the rats died between birth and weaning, and the body weight loss of the survivors was increased. After 100 rads, 62/133 (47%) died at birth on day one; and 103/133 (77.4%) died before weaning. A large and significant decrease in body weight persisted in the survivors. After 150 rads of fission neutrons, all 95 rats died within 48 hrs. of birth. From cross-fostering experiments, we believe this is a direct effect of radiation on the embryos and not an indirect action through the mother or her milk. The LD50 for the period from birth to weaning is approximately 75 rads of fission neutrons.

Organ weight loss studies were conducted daily for the first week after birth. There was a significant loss of total body weight in the irradiated animals. Significant weight losses were found in the liver, kidney, brain, and testis of the neutron-irradiated rats compared with their controls. The spleen, lungs, duodenum, and stomach lost weight, but not significantly. The bone marrow appeared depleted in the irradiated long bones, yet the spleen maintained active hematopoiesis one to two months after neutron exposure.

The most significant damage was found in the central nervous system and in the testis one month after neutron exposure.

Transuterine Migration in the Rat. R. E. GARTH, M. J. LEVINE, MEG GREEN, MARK EDWARDS AND FLOYD DENNEY, University of Tennessee at Chattanooga.

Transuterine migration is well documented in a number of species, but its occurrence in rats has been highly doubtful. This doubt is based on anatomical structure plus a paucity of documented occurrences.

Evidence for a case of transuterine migration in a Long-Evans rat has been obtained in our laboratory. A virgin rat, unilaterally ovariectomized at about 30 days of age, was first mated at 62 days of age and bore 11 young. Two weeks later during a routine laparotomy 15 nidation (implantation) sites were found, 13 on the non-surgically treated side and 2 on the other. These two sites were small as were two others, indicating early reabsorption of the embryos.

The uterus was removed, preserved in 10% formalin, cleared for 4 weeks in changes of hydrogen peroxide and then toluene. The pigmented sites persist and no explanation other than reabsorbed nidation sites seems plausible.

Recent Advances in Knowledge of the Brown Recluse Spider and Its Bite. H. B. REED, JR., Middle Tennessee State University.

The range of the brown recluse spider centers in Arkansas and includes 15 states. Sporadic occurrences of the spider and cases

of its bite outside the range are reported. In addition to the occasional necrotic lesion caused by the bite, and the less frequent intravascular hemolysis and hematuria, one instance of paralysis of both legs (with residual effects after 4 yr) resulted.

Recent literature indicates the development of a serodiagnostic test and a lymphocyte transformation test for previous exposure to brown recluse venom. Studies indicate that the venom of both sexes contains eight proteins. The value of corticosteroids in treatment of the bite is controversial. No effective antivenin is available in the United States. Control measures include lindane where needed.

Cases of brown recluse bite in Middle Tennessee are documented with color slides.

Anesthesia During the Civil War. D. I. PAV AND B. L. SIMMERMAN, East Tennessee State University.

General anesthesia on large scale was used for the first time by the British medical officers in the Crimean War at Balaklava. American troops used ether as an anesthetic agent in the Mexican War at Vera Cruz. Use of chloroform is reported to have had a first record in the Austro-Sardinian War.

The various anesthetic agents and mixtures used in the Civil War, and their evaluation by contemporary medical authorities, are cited. The effect of anesthesia on surgical procedures, survival rate, shock and psychological disturbances is discussed.

Ultrastructure of the Paraventricular Nucleus From Rats with Hereditary Diabetes Insipidus. MARGARET W. HOUGLAND, East Tennessee State University.

Ultrastructural studies were made of the paraventricular nucleus in the hypothalamus of rats (Brattleboro strain) which have a genetic defect for vasopressin synthesis. Neurosecretory cells of the nucleus exhibit hypertrophy of the perikaryon, nucleus, nucleolus, axon and dendrites. Cisternae of the rough endoplasmic reticulum are in disorganized arrays. Pleomorphic lysosomes frequently containing electron lucent vacuoles are the most conspicuous organelle. Neurosecretory granules are virtually absent in most perikarya and axons. Small dense core vesicles are associated with Golgi complexes or are scattered throughout the cytoplasm. Golgi cisternae are often in disarray and in individual stacks of short, flattened cisternae. Apparently there are three forms of multivesicular bodies, one of which has continuity with the smooth endoplasmic reticulum. The perikaryal margin usually does not exhibit cytoplasmic lips as in neurosecretory cells from control animals. Other cells of the neuropil resemble those in the control neuropil.

Pitfalls in the Analysis and Interpretation of Sugars in the Blood. LEONARD B. VICTOR, University of Tennessee.

The presentation will briefly review pathophysiological considerations, methodologies, specimen handling, and other influences (nutrition, circadian) on the interpretation of laboratory results of blood sugars.

Sudden Death Due to Spontaneous Rupture of the Spleen—Post-Mortem Serology Establishes Diagnosis of Infectious Mononucleosis. JAMES MICHAEL MASON AND JAMES SPENCER BELL, University of Tennessee Center for Health Sciences.

An 18 year old male caucasian was found dead in his bathroom with no external signs of trauma. The subject had been ill for 10 days and had been treated for symptoms of viremia the day before his death. Autopsy revealed rupture of the spleen with massive hemorrhage and the presence of atypical lymphocytes. Laboratory tests on post-mortem samples confirmed the diagnosis of infectious mononucleosis.

Morphologic Findings in a Fatal Case of Paroxysmal Nocturnal Hemoglobinuria. EDWARD O. UTHMAN, M.D., University of Tennessee Center for the Health Sciences.

Paroxysmal nocturnal hemoglobinuria is an uncommon blood disease characterized by unusual sensitivity of erythrocytes to complement-mediated lysis. A case of this disease progressing to fatal hepatic failure is presented with special emphasis on correlation between the clinical picture and autopsy findings. The cardinal morphologic feature is diffuse hepatic vein thrombosis, which produced profound destruction of liver parenchyma through a process similar to that seen in cardiac cirrhosis. A novel finding is marked adventitial fibrosis and subendothelial proliferation of the pulmonary arterial tree, a picture reminiscent

of that seen in chronic pulmonary hypertension, despite the fact that other clinical and postmortem evidence did not substantiate that diagnosis.

The Effects of SPS on Fastidious Organisms in Blood Cultures. JACQUELYN BARD, MARY K. ROBISON, L. B. VICTOR, AND B. R. JENNINGS, The University of Tennessee Center for the Health Sciences.

Sodium polyanetholsulfonate is the most common anticoagulant in commercial blood culture media. The optimum concentration of SPS has never been agreed upon, perhaps because investigators have used different media, with some containing other additives such as sucrose and cysteine. The toxicity of SPS for certain fastidious microorganisms has apparently been ignored by commercial manufacturers in the belief that these organisms account for a very small percentage of positive cultures. In our hospital population, the toxicity of SPS for microorganisms in the genus *Neisseria* is a serious consideration. We have found lower concentrations of SPS (0.025%-0.03%) to be more satisfactory for the isolation of these organisms, and suggest that users of commercial blood culture media make a careful choice in selecting a product for their patient population.

Corynebacterium Equi Infection in the Immune Compromised Patient. GARY LIPSCOMB, JACQUELINE BARD, LEONARD B. VICTOR, AND BILLY RAY JENNINGS, University of Tennessee Center for the Health Sciences.

Infections with organisms of lower pathogenicity and greater antibiotic resistance are a major cause of morbidity and mortality in patients with compromised immune systems. These are patients receiving immunosuppressive agents for various neoplastic conditions or to prevent rejection of transplanted organs, most frequently renal transplants. Although there are numerous well known opportunistic agents infecting these individuals, recently cases of pulmonary infection with bacteremia due to *C. Equi*, a soil residing, diphtheroid pathogenic in horses, cattle and swine, have been recognized.

Unless certain characteristics of these organisms are recognized, they may be regarded as normal flora or contaminating diphtheroid. A case of *C. equi* infection in a patient who was immunosuppressed for renal transplantation is reported.

Nonrandom Distribution of Blood Transfusion Reactions in Time. JAMES M. MASON AND LEONARD B. VICTOR, University of Tennessee Center for the Health Sciences.

The transfusion reactions reported at City of Memphis Hospitals over the past three years were reviewed. There was an approximately equal distribution of "allergic" and "febrile" reactions, with only one hemolytic reaction reported. Fewer than one percent of transfusions resulted in reported reactions. These statistics are all quite similar to reactions at other institutions. When reactions were examined by month, the fewest reactions were found to be reported in March with the most in August and September. The nonrandom distribution of these reactions during the 24 hours of the day was striking. The lowest frequency of transfusion reactions occurred with units begun between 7:00 and 9:00 a.m. (relative frequency, 1:15); the highest frequency of reactions were induced by units begun between 7:00 and 9:00 p.m. (relative frequency, 3.04). Transfusion reactions were reported significantly more frequently ($P=0.0005$) when transfusions were begun between 3:00 P.M. and 1:00 A.M. than when begun between 1:00 a.m. and 3:00 P.M.

PHYSICS-ASTRONOMY SECTION

MARVIN TIDWELL, *Chairman*

Luminosity-Distances and Age Factors for Model Universes which have a Non-zero Cosmological Constant. RONNIE C. BARNES, Lambuth College.

The motivation, techniques, and results of research into the properties of relativistic model universes which have a non-zero cosmological constant will be discussed. Preliminary results are:

- (1) the luminosity-distance function is most sensitive to redshift when the deceleration parameter q_0 is close to -1 and when the density parameter σ_0 is close to zero.
- (2) the age factor is greatest when $q_0 = -1$ and $\sigma_0 = 0$.

SCIENCE-MATHEMATICS TEACHERS SECTION

R. K. FLETCHER, JR., *Chairman*

Pre-Service Mathematics Experiences for Grades 3-9; Bridging the Gap Between Theory and Practice. DANNY W. HIGDON, Tennessee Technological University.

This session traces the development of a 1975 field based pilot program in elementary mathematics methods for education majors at Tennessee Technological University. The history of the program reveals the transformation from a "rather typical" on-campus methods course to a totally field based program. This program was the impetus for other elementary methods courses becoming field based operational and offering a number of field-related experiences for prospective teachers prior to student teaching. During the fall of 1977 the first such program for secondary mathematics methods was implemented at a local junior high school with plans for expanding the program to include senior high experiences during the 1978 winter quarter.

The main focus of the program has been on making the educational community realize that in order to prepare elementary and secondary teachers of mathematics, the universities and public schools must work cooperatively.

Why Waste a Study Hall? The Use of an Individualized Approach to Teaching Mathematics. ELIZABETH M. BLY, Pickett County High School.

A collection of 144 tasks was designed to give eighth grade students with free study hall time an opportunity to explore extra topics in mathematics. Some tasks are complete in themselves while others require the completion of one or more prerequisite tasks. The tasks were originally intended to be completed with no teacher assistance but it was found that teacher guidance was helpful. Included are tasks for students of all ability levels.

Special care was taken to correlate mathematics with other subjects such as history and English. Exercises were included which give students an opportunity to display artistic talent since there is no art program in the school.

Students were allowed to work on the tasks for a two month period at the end of the year and the following observations were made:

- (1) Students of all ability levels were anxious to participate.
- (2) Many students completed tasks at levels beyond that normally demonstrated in the classroom.
- (3) There were no discipline problems.

Junior High and Senior High Science Textbooks - Are They Environmentally Oriented? A. PAUL WISHART, The University of Tennessee.

Awareness and interest by educators and other groups has developed greatly during the past decade in environmental problems and concerns. One evidence of this expanding concern has been an increased involvement in environmental education activities on the part of public secondary education.

A major source of instructional content in many secondary classrooms is a single textbook or, at best, a single textbook augmented by one or more supplementary texts. This situation is particularly true with the adoption and implementation of national science curriculum programs (eg. BSCS, PSSC, ESCP, etc.) in recent years. An increase in the amount and quality of environmentally related content in science textbooks is essential to providing increased consideration of such content in secondary classrooms.

Closely related to this situation is the need for perspective teachers to be able to assess and select textbooks which devote adequate attention to environmental problems and concerns.

Such an assessment process is predicated on the assumption that appropriate criteria for such selections have been identified. At the time of this study, no such criteria had been identified.

The purposes of this research were to:

1. Develop and pilot test a Textbook Evaluation Checklist to be utilized in assessing, qualitatively and quantitatively, the

- (3) if $q_0 = -1$ and $\sigma_0 = 0$ there is no cutoff in the luminosities of quasars as a function of redshift.

An Interpretation of Leonardo's Mechanics. F. L. CULP, Tennessee Technological University.

Selected statements concerning the subject of mechanics found among the notes of Leonardo da Vinci and translated by Ivor B. Hart will be presented and interpreted. These interpretations are based on the recognition that Leonardo had to express his thoughts with a vocabulary inadequate to his needs. The paper suggests that Leonardo had a clear intuitive understanding of inertia, Newton's law of motion, and Newton's law of action and reaction.

Response of Undergraduates to Special Projects in Computer Modeling. DAVID E. FIELDS, Oak Ridge National Laboratory.

"How does one stimulate students to extend their interests beyond the narrowly-defined boundaries of a textbook and experience the rewards and frustration of original research?" One answer to this question may be found in computer modeling of physical systems. Simulations of and modifications to such systems, even though "on paper", can be quite instructive. Several undergraduates were given the opportunity to undertake modeling projects; most were intrigued by the idea and eventually presented papers at a TAS student session.

Bioelectric Growth Mechanisms in Plants. FRANCIS X. HART, University of the South.

A series of experiments to measure the effect of applied electric fields on the growth of pole beans is described. Of particular importance is the damage and consequent collapse of bean plants due to a decrease in turgor pressure. This decrease is produced by a sharp increase in evapotranspiration due to a disruption of the boundary layer surrounding the leaf by the corona discharge.

The Temperature Dependence of the Specific Heat of Aluminum. FRANKLIN CURTIS MASON, Middle Tennessee State University.

A description of a method for determining the behavior of c_p vs. T for aluminum as performed by students in an advanced laboratory at Middle Tennessee State University is presented.

The method consists of measuring the average specific heat of aluminum over various ranges of temperature and then using these values to determine the curve fitting parameters a , b , and c in an expression for average specific heat, given by

$$c_p = a + b(T_1 + T_2) - c/T_1 \cdot T_2.$$

This expression was in turn derived from the empirical relationship

$$c_p = a + 2bT - c/T^2.$$

The calorimetry is based on the well-known method of mixtures and the method of differential evaporation of liquid nitrogen which is discussed briefly.

For anyone wishing to perform similar experiments, a list of equipment and supplies is given, and several points of instruction concerning the experiment are mentioned.

Is Charm Really Necessary in Physics? M. R. MAYFIELD, Austin Peay State University.

The jargon of physics appears to increase in magnitude and complexity at an accelerated rate. Students who are not really sure about the characteristics attributed to electrons, protons, and especially antineutrons, are even more skeptical about the characteristics of the "new" particles. Color is acceptable; strangeness they buy; but charm?

Oak Ridge Associated Universities Student/Faculty Programs 1977-78. K. E. PAULSON, Oak Ridge Associated Universities.

Oak Ridge Associated Universities has provided a variety of educational opportunities for the academic community for many years. The programmatic emphasis has evolved during this time to reflect the training mission of the various funding agencies of the programs. The programs for 1977-78 will be presented under the sponsorship of the Department of Energy. The 1977-78 programs for college and university students and faculty members will be discussed in detail.

degree of environmentally related content in currently used science textbooks.

2. Determine the usefulness of this textbook evaluation process as an effective instructional methodology in pre-service and in-service teacher education programs.

3. Develop a series of generalizations and recommendations describing the environmentally related content in currently used science textbooks.

4. Develop a checklist that will assist teachers and administrators in the selection of science textbooks and related materials.

A Prospective Model for Metric Education Targeted for Classroom Teachers. CARL SEITER, Tennessee Technological University.

The need for a planned transition into metrication for most Americans is not being met. If and when metrification promises to become a way of life, there may well be a mild panic in the public coupled with great resistance to the system. Consequently, scientists and science teachers already so familiar with the metric system, may be called upon to conduct workshops and training programs for certain target populations of varying composition, as well as act as spokesmen and interpreters.

This paper explores one program model that was implemented in Warren County Tennessee in August, 1977 for its public school teachers. A combination of lecture and 'hands-on' experiences with a culminator activity in the surrounding community for its conclusion comprises the body of this model. Identifying some of the variations possible for different populations along with their needs/expectations is discussed.

A Beginner's Guide To Earth Science Teaching. CHARLES C. CANTRELL, Tennessee Technological University.

Teaching philosophies and methods are compared, with emphasis being placed on a practical blend of traditional and modern ideas. Lists of classroom goals, and behavioral objectives are included. The use of various teaching materials, texts and audio-visual aids are discussed. Problem areas ranging from those of administration to ones of classroom mechanics are also treated. An annotated bibliography to earth science text and laboratory materials, teacher curriculum and resource guides, reports, and a key to sources for audio-visual aids follow the text.

A Summary of Research Literature Predicting Success in College Chemistry. RICHARD K. FLETCHER, JR., Tennessee Technological University.

Twelve empirical research studies are reviewed which relate to prediction of success in college chemistry. The results from these studies and another summary of twenty-four studies by another author served as background for the summarizing comments which follow. The foremost conclusions reached from this survey of literature are that the probability for successfully completing a course in freshman college chemistry are significantly enhanced by successful completion of the high school courses in chemistry, physics and especially mathematics.

Completion of one of these courses is helpful but not as pronounced as a combination two or more. The single best predictor of success is the student's composite score on the ACT or SAT. Correlations between these scores and grades in college chemistry usually range from 0.50 up to 0.65. Multiple correlation coefficients are usually in the range between 0.60 and 0.70. Students with average to weak scores on the ACT and who have not completed high school courses in chemistry, physics and mathematics should be encouraged to do remedial work before entering college chemistry courses.

The Effect of Concrete and Formal Piagetian Levels on Learning for Preservice Science Teachers. CARLTON H. STEDMAN, Austin Peay State University.

Preservice elementary students in two classes were classified as concrete operational or formal operational after completion of Burney's "Objective Formal Reasoning Instrument." Seven concrete and seven formal students were randomly selected in each class and the classes were then randomly assigned to two instructional sequences: one, concrete to abstract, and two, abstract to concrete.

Achievement and attitudes were evaluated for two primary hypotheses:

1. Achievement levels of concrete and formal subjects will vary when they are instructed in: (a) concrete tasks and in (b) abstract tasks.

2. Attitudes will vary between concrete and formal subjects when they experience: (a) concrete tasks and (b) abstract tasks.

Achievement levels of students who were formal operational were significantly better regardless of the sequencing or tasks evaluated, but no differences were noted in attitudes between the groups.

ZOOLOGY SECTION I

MICHAEL J. HARVEY, Chairman

Effects of the Winter of 1976-1977 on the Population Size and Reproductive Activities of Eastern Bluebirds in Northwest Tennessee During 1977. T. DAVID PITTS, University of Tennessee at Martin.

The abnormally cold and snowy winter of 1976-1977 was responsible for a reduction in the number of Eastern Bluebirds (*Sialia sialis*) in northwest Tennessee. Many bluebirds died in roost cavities during January, 1977. The 1977 breeding population on a 1,800 ha study area was approximately 50% smaller than it was in 1976. Nesting success in 1977 was higher than normal primarily because fewer nests were destroyed by predators.

Genetic Variation in Clethrionomys gapperi. MELVIN L. BECK AND MICHAEL L. KENNEDY, Memphis State University.

Polyacrylamide gel electrophoresis was used to examine genetic variation in *Clethrionomys gapperi* collected from the Appalachian Mountains of eastern Tennessee and western North Carolina. Allozymic variation in 13 proteins encoded by 15 genetic loci was analyzed from eight populations of *Clethrionomys gapperi*. Ten loci were found to be monomorphic in all populations. The glucose metabolizing proteins showed no variation, while the greatest contributors to genetic variation were the non-enzymatic proteins. The mean value of heterozygosity for this species was 5.1%.

Activity Patterns of the Painted Pocket Mouse, Liomys pictus. MICHAEL C. WOOTEN, ROGER D. DEW, AND MICHAEL L. KENNEDY, Memphis State University.

Activity patterns of two male and two female painted pocket mice, *Liomys pictus*, were studied near El Cobano, Colima, Mexico, from 31 December 1976 to 9 January 1977. The study was conducted, at the trapsite, in an open-air structure which provided shelter from direct sunlight, but allowed natural light and dark periods. Rustrac event recorders were activated by mercury switches attached to treadles in the nest cages. The animals showed high activity throughout the night with activity beginning during dusk and ending within 1 hour and 15 minutes after sunrise.

Population Densities of the Raccoon, Procyon lotor. DONALD W. ALLSBROOKS, ROGER D. DEW, AND MICHAEL L. KENNEDY, Memphis State University.

Population densities of the raccoon (*Procyon lotor*) were investigated at two sites on Shelby Wildlife Management Area, Shelby Co., Tennessee during 1976-77. Animals were live trapped, tagged, and released. Capture-recapture techniques were used to estimate densities. A total of 21 raccoons was captured in 846 trap nights. Densities of approximately one raccoon per 1.5 ha on one area and one raccoon per 8 ha on the second area were estimated.

Interlocality variability in biochemical characters of the raccoon, Procyon lotor. ROGER D. DEW AND MICHAEL L. KENNEDY, Memphis State University.

Starch gel electrophoresis was used to analyze the genetic variability of the raccoon (*Procyon lotor*) in Tennessee. Variation among 8 proteins encoded by 10 loci was investigated in 225 specimens from 19 counties. These counties represented eight physiographic regions of Tennessee. Results indicate that there is little interlocality variability in the proteins examined.

Electrophoretic Patterns of Ochrotomys nuttalli and Four Species of Peromyscus. PHYLLIS K. PRICE AND MICHAEL L. KENNEDY, Memphis State University.

While electrophoretically examining *Ochrotomys nuttalli*, *Peromyscus maniculatus*, *P. leucopus*, *P. gossypinus*, and *P. attwateri* collected from Oklahoma, Arkansas, or Tennessee; species-specific protein patterns were noted. Blood samples electrophoresed on polyacrylamide gels yielded species-specific patterns of hemoglobin and transferrin. Some specificity was shown in sorbitol dehydrogenase, phosphogluco isomerase, glutamate oxalate transaminase, and lactate dehydrogenase from kidney samples electrophoresed on starch gels. Also, some intraspecific variation was exhibited in hemoglobin, phosphogluco isomerase, and glutamate oxalate transaminase. Other investigators have observed similar banding patterns for these species.

A Numerical Analysis of the Small Mammal Component of Microhabitats in the Blue Mountains of Oregon. STEPHEN L. LINDSAY, Memphis State University.

This study has been an attempt to determine ecological relationships among a group of microhabitats and among several species of small mammals using two numerical analytic techniques, cluster analysis and discrepancy analysis. Microhabitats in the Blue Mountains of Umatilla County, Oregon were sampled for the ecological parameters of small mammal species, dominant plant species, facing of slope, soil texture, and ground-level illumination (a measure of vegetative cover). The Coefficient of Community was used to determine degree of similarity from which "Habitat Communities" and "Species Communities" were identified. Each Habitat Community consisted of those microhabitats related in terms of the sampled parameters above the 70% similarity level and each Species Community consisted of those small mammal species related in terms of the sampled parameters above the 60% similarity level. Habitat Communities indicated four distinct ecological areas and Species Communities indicated small mammal species groups which were seen to share preferences for particular habitat conditions. The use of numerical analysis as a tool in ecogeographic characterizations was shown to be helpful in defining communities on the basis of their component parts.

Distribution of the Prairie Vole, Microtus ochrogaster, in Arkansas. DWIGHT MOORE, Memphis State University and GARY A. HEIDT, University of Arkansas at Little Rock.

Through extensive and selective trapping, the range of the Prairie Vole, *Microtus ochrogaster*, is shown to be much more extensive than was previously thought. The range is shown to cover much of the eastern half of the state north of the Arkansas River. Previously published papers support the idea that the population of voles in the east-central part of the state is relict from those in the northeast. Our studies show that this is not the case, and in fact, the populations throughout the eastern part of the state are continuous. Trapping was done along the railroad right-of-way as it appears that the railroad system is providing a means of maintaining the species as available habitat is destroyed due to agricultural practices. The railroad system may also be providing a corridor for range extension through the state.

A Systematic Analysis of the Prairie Vole, Microtus ochrogaster (Wagner), in Arkansas. J. A. HUGGINS, Memphis State University and V. R. MCDANIEL, Arkansas State University.

A 16-month taxonomic study was conducted to test the hypothesis of a distinct population of *Microtus ochrogaster* in Central Arkansas and to determine the nature of any morphological and/or karyological divergence of this population. Analysis of variance for skull morphometric data revealed only slight variation between the Central Arkansas population and the more northern population, while cytological analysis confirmed identical diploid numbers, fundamental numbers, and chromosomal morphologies for all groups. Conclusive evidence for the contiguity of the northern population and the reportedly disjunct Central Arkansas population was provided with documentation of established populations in those counties previously thought to separate the two populations.

The absence of morphological and cytological divergence, and in fact the absence of a disjunct population, supported the concept that gene flow had not been interrupted and that all sam-

pled populations belong to the same gene pool. The presence of *M. ochrogaster* in Central Arkansas was explained as a recent colonization of new ranges as afforded by the advent of the railroad.

Effect of Soft Drink Consumption on Population Parameters of House Mice. C. KENYON WAGNER, Southwestern at Memphis and Clemson University.

Recent studies reported by the press have indicated possible health hazards associated with the intake of sugar and sugar substitutes upon the individual. However, these substances are seldom tested for effects at the population level. A long term experiment was conducted by an upper level ecology class to examine population dynamics of mouse populations as affected by the soft drinks Coca Cola and Tab. Water was used as a control. Results show sharp differences in the growth rates of the populations traceably to differences in birth rates. In addition the intake of food and liquid was different between the populations while the health of individuals in the populations as measured by weight gain or loss showed no difference.

Status of the Endangered Big-eared Bat, Plecotus townsendii virginianus, in Kentucky. MICHAEL J. HARVEY, Memphis State University.

The Virginia big-eared bat, *Plecotus townsendii virginianus*, will soon be added to the United States list of endangered species. The taxon is found in three separate populations centered in western Virginia, eastern West Virginia, and eastern Kentucky. The total number surviving is estimated to be 2500-3000 individuals. The entire Kentucky population is thought to hibernate in a single cave. Estimates of the hibernating colony size during the past 14 years range from 472 to 1000 bats. As many as 300 individuals, mostly females, have been reported to be present in the cave during the summer. The cave will be listed as critical habitat for *P. t. virginianus*.

ZOOLOGY SECTION II

WILBURN A. SLIGER, Chairman

The Effects of Aldrin and Heptachlor on Fin Regeneration in the Pugnose Minnow, Notropis anogenus. JOSEPH R. TOMASSO, JR. AND GEORGE G. MURPHY, Middle Tennessee State University.

The effects of the organochlorine pesticides aldrin and heptachlor on caudal fin regeneration in the pugnose minnow, *Notropis anogenus*, were studied. Twenty-four hour L.C. 50's were determined for each pesticide and the effects of fractional concentrations of these values on regeneration evaluated. Fish were allowed to regenerate in the different concentrations for 14 days. Regeneration was measured on days 7 and 14.

Neither pesticide at any concentration significantly retarded regeneration by day 7. By day 14 aldrin in concentrations as low as 8.4 ppb (1/10 of L.C. 50) and heptachlor as low as 11.0 ppb (1/20 of L.C. 50) significantly retarded regeneration. The effects of aldrin and heptachlor concentrations equivalent to 1/10 of their respective 24 hour L.C. 50 values were not significantly different. However, effects of aldrin and heptachlor concentrations equivalent to 1/20 of their respective 24 hour L.C. 50 values were significantly different.

Effect of Acclimation Temperature on Malate Dehydrogenase Activity in Channel Catfish, Ictalurus punctatus. MARIE I. WRIGHT AND KENNETH B. DAVIS, Memphis State University.

The cellular mechanisms by which poikilothermic organisms acclimate to a wide variety of temperatures are poorly understood. The possible mechanisms of adaptation may include the presence of isozymes with different temperature optima or an increase in the number of enzyme molecules. Malate dehydrogenase (MDH) activity was measured from liver extracts of channel catfish acclimated at 10°C and 30°C for three weeks. Enzyme activity and electrophoretic analyses were determined at 10°, 25°, and 30°C. Enzyme activity from both groups of fish increased with increasing assay temperature.

Enzyme activity was greater from fish acclimated to 10°C than 30°C at all three assay temperatures. Electrophoretic mobility of MDH indicated only one form, however, stain density was consistently more intense in extracts from fish acclimated at 10°C. These data suggest that acclimation to low temperature in

channel catfish results in an increased number of MDH molecules, and not induction of an MDH isozyme.

Relationship of Calcium and Salinity on Electrolyte Metabolism in Channel Catfish. CHERYL A. GOUDIE AND KENNETH B. DAVIS, Memphis State University.

Addition of calcium to water has been implicated in reducing electrolyte imbalance which often accompanies various types of stress in fish. Tissue sodium and chloride levels and intracellular water distribution was compared in channel catfish acclimated to 0, 7.5, and 11 g/liter CaSO_4 tap water and in calcium enriched (1.07 g/liter CaSO_4) tap water at 10°C. In fish from 7.5 g/liter sodium chloride low in calcium, slight elevations in plasma sodium and chloride, chloride space, and muscle sodium occurred, but muscle water decreased when compared to those in 0 g/liter. These effects were more dramatic in fish held in 11 g/liter sodium chloride. Fish held in calcium enriched tap water at 0 and 7.5 g/liter sodium chloride revealed no apparent differences in these parameters. Elevations in 11 g/liter sodium chloride in calcium enriched water were not as dramatic when compared to 11 g/liter sodium chloride in aged tap water. These data suggest that the presence of calcium diminishes the effects of high salinity at this temperature. Environmental calcium may aid electrolyte regulation and water distribution in fresh water fish in elevated salinities.

Length-Weight Relationship in Brook Trout *Salvelinus fontinalis* (Mitchell) of the Great Smoky Mountains National Park. JOHN R. ROBINETTE AND ERIC L. MORGAN, Tennessee Technological University.

The length-weight relationship was calculated for 318 brook trout taken from five different streams in the Park. Each fish was weighed to the nearest gram and measured to the nearest millimeter. Data was employed in an SPSS computer program to plot and display separately actual and calculated weight over length. The slope of the regression line for the actual weights was .58. The calculated confidence limits were 93.31% was a standard error of 9.14. Confidence limits for calculated weights were 97.06% with a standard error of 5.55. The slope of the regression line was .55. These comparisons show a definite relationship between length and weight, and that the calculated length-weight relationship is a reasonable model for predicting the weight of brook trout in the Park.

This research was supported by funds provided by the USDI, National Park Service, Southeastern Regional Office, Atlanta, Georgia; and by the Aquatic Ecology Fund, Tennessee Technological University, Cookeville, Tennessee.

Isozyme Variation in the Eastern Brook Trout, *Salvelinus fontinalis*. WILLIAM F. BRANDES, JOHN W. HARRIS, AND R. DON ESTES, Tennessee Technological University.

Eastern brook trout were electrophoretically examined for 10 different proteins. Three enzymes, phosphoglucose isomerase (PGI), isocitrate dehydrogenase (IDH), and lactate dehydrogenase (LDH), extracted from liver and muscle tissues, were found to be polymorphic at one or more loci. Significant differences in allelic frequencies were found between the 13 allopatric populations sampled. A high degree of polymorphism was observed at the PGI-1 locus, where four alleles were identified. Populations from the Great Smoky Mountains National Park were fixed for loci observed to be polymorphic in other populations sampled. It is hypothesized that this lack of genetic variation is due to a high degree of inbreeding characteristic of the small brook trout populations present in the park.

The Genetic Control of Isocitrate Dehydrogenase Isozymes in Eastern Brook Trout, *Salvelinus fontinalis* (Mitchell). JOHN W. HARRIS AND WILLIAM F. BRANDES, Tennessee Technological University.

Liver samples were collected from 13 allopatric brook trout populations throughout the eastern United States and from Utah. The samples were extracted, subjected to starch gel electrophoresis, and the gels were stained for isocitrate dehydrogenase (IDH). The results indicate that IDH in brook trout is a dimer coded for by two different loci. A total of four alleles were identified on the basis of the observed migration rates of the homodimers composed of the subunits which the various alleles specify. The data suggest that at least two of the alleles occur at both loci. The distribution of alleles at each locus was found

to vary with the population.

Methods of Estimating Time of Annulus Formation on Fish Scales. FRANK J. BULOW AND J. FRED HEITMAN, Tennessee Technological University.

An essential aspect of the scale method for determining age and growth characteristics of a fish population is the recognition of the annulus or year mark. This paper presents two methods for determining if the annulus of the current year is present and two methods for estimating the date of annulus formation. Annulus formation, reflecting onset of active feeding and growth, generally occurs earlier in southern latitudes due to the influence of temperature and photoperiod. Data are presented for bluegills (*Lepomis macrochirus*) from three Tennessee lakes at approximately latitude 36°N.

A Comparative In Vitro Study of the Effects of Various Balanced Saline Solutions on Respiration Rates of Liver Tissues of Three Fish Species. PORTIA DELILAH COTHRON AND C. B. COBURN, JR., Tennessee Technological University.

A balanced saline solution for fish tissues was needed for use in a manometric experiment dealing with oxygen uptake by fish liver. Since little information dealing with balanced saline solutions for fish tissues was available in the literature, this research was begun in order to obtain an indication of whether a significant difference is produced among fish livers respiring in varied fish and mammalian solutions. Using literature values, several balanced saline solutions were postulated and were compared to Krebs-Ringer Phosphate.

Results of this research indicated that differences in the basic fish and mammalian salines tested did not significantly affect cellular respiration in fish liver mince. In liver tissues which contained sufficient oxidizable substrate, presence or absence of glucose and differences in ionic constituents of the fish and mammalian solutions tested had no effect on cellular respiration in liver tissue mince during a 45 minute period. In cells apparently lacking sufficient oxidizable substrate, glucose-containing media produced results significantly different from those yielded by non-glucose-containing media. Effects of pH and of temperature were observed.

Seasonal Variations in Food Habits of Burgess Falls Lake Bluegills. WILLIAM F. HUDSON AND FRANK J. BULOW, Tennessee Technological University.

Monthly stomach staples of bluegills (*Lepomis macrochirus*) were collected from Burgess Falls Lake, an impoundment of Falling Water River, from November 1976 through October 1977. Analysis of stomach contents revealed that a variety of aquatic invertebrates made up the major portion of the diet, but some terrestrial insects, plant material, fish eggs and mosquito-fish (*Gambusia affinis*) were also consumed. Definite seasonal variations in total volume plus volumes and numbers of specific taxa were noted. Heavy predation on crappie eggs (*Pomoxis* sp.) occurred in April. This food consumption data will be analyzed for possible correlations with growth data concurrently collected, including RNA-DNA ratios, liver weight indices, and condition factors.

Incidence of Occurrence of the Copepod Parasite *Lernaea cyprinacea* in a Stream Fish Population. FRANK J. BULOW AND JAMES R. WINNINGHAM, Tennessee Technological University.

The anchor worm, *Lernaea cyprinacea*, is a fairly common copepod parasite of fish being particularly problematical in hatcheries and fish farms. Literature concerning the natural occurrence of this parasite in stream fish populations, however, is sparse. In the present study, 15 species of fishes from Blackburn Fork, Putnam County, Tennessee were examined for this parasite. Incidence of occurrence, degree of infection, and location on the fish body were recorded. Several cyprinids including *Campostoma anomalum* and *Rhinichthys atratulus* were particularly susceptible to infection, while other species including *Cottus caroliniae* showed no incidence of infection. The parasite was most often found at the base of a fin, primarily the dorsal fin. The effect of season and stream order on incidence of occurrence was also investigated.

The Influence of Temperature on Feeding-Growth Relationships of the Bluegill, *Lepomis macrochirus*. WILLIAM R. WOLTERS AND FRANK J. BULOW, Tennessee Technological University.

Bluegills (*Lepomis macrochirus*) were held at uniform tem-

peratures of 10, 15, 20, 25, 30 and 33 C and fed to satiation for two weeks. Food consumption rate increased with temperature to a peak at 30 C and then declined at 33 C. Relative growth rate showed a similar pattern, but with a peak at 25 C. Peak conversion efficiency or efficiency of utilization of food for growth also occurred at 25 C. Maintenance requirements or amount of food needed to maintain a constant body weight steadily increased with temperature. Epaxial muscle RNA-DNA ratios reflected trends in food consumption and growth, verifying the ratio as an indicator of short-term growth rate.

Seasonal Variations in Liver and Muscle RNA-DNA Ratios of the Bluegill, *Lepomis macrochirus*. MICHAEL E. ZEMAN, JAMES R. WINNINGHAM, AND FRANK J. BULOW, Tennessee Technological University.

RNA-DNA ratios of epaxial muscle and liver tissue samples from a natural population of bluegills (*Lepomis macrochirus*) were recorded from December 1976 through September 1977 to: (1) field test the RNA-DNA ratio technique of measuring short-term growth rate; (2) measure seasonal variations in relative growth rate as indicated by this technique; and (3) study the effects of various environmental and physiological factors on the RNA-DNA ratio and relative growth rate. This study will continue through November 1977 to complete the annual cycle, but results through September are reported here.

Use of Liver Weight as an Index to Fish Condition. FRANK J. BULOW, C. B. COBURN, AND WILLIAM R. WOLTERS, Tennessee Technological University.

Bluegills were held at 25 C in separate aquaria for two weeks and fed mealworms at 0, 2.44, and 4.00% of their total body weight per day. Relative growth rate, liver RNA/DNA, muscle RNA/DNA, and liver-body weight ratio increased with food ration level, indicating the liver weight as a possible easily measured indicator of fish condition or growth status. Monthly liver-body weight ratios of bluegills from Center Hill Reservoir and Cookeville City Lake showed negative correlations with temperature, with ratios being lowest during the summer. Liver-body weight ratios of Cookeville City Lake bluegills were consistently higher than those of Center Hill Reservoir bluegills throughout the year. Interpretations of these results are discussed.

Reaction To Color Placement In *Betta splendens*. KATHY F. VAL, The University of Tennessee at Chattanooga.

Effects of color placement diagrams upon the display mechanisms of *Betta splendens* were determined. The presentation of scale diagrams with various anatomical color combinations to individual *Betta* in a series of trials provided data. The diagram without coloration, with only natural gill coloration and with gill and tail coloration elicited no response. Several combinations of color and placement caused slight aggressive display, while the diagrams with full natural coloration, with dorsal fins and spread tail coloration and with dorsal fin coloration alone provided the greatest degree of aggressive display recorded.

The Fishes of Indian Creek, Obion County, Tennessee. BRIAN JAMES, DANNY WILLIAMS, AND W. A. SLIGER, University of Tennessee at Martin.

Indian Creek, a 20.9 km spring fed tributary into Reelfoot Lake, contains a fish fauna that more closely resembles the fauna of the Tennessee River drainage than the Mississippi drainage. A total of 21 species have been taken from the stream.

The species that are atypical for the area include; *Etheostoma spectabile* (Agassiz), *Etheostoma squamiceps* Jordan, *Campostoma anomalum* (Rafinesque), *Phoxinus erythrogaster* (Rafinesque), *Rhinichthys atratulus* (Hermann), *Catostomus commersoni* (Lacepede), and *Moxostoma erythrum* (Rafinesque). These species are not known to occur in the Obion River drainage of Tennessee except in the bluff area along the eastern rim of Reelfoot Lake.

ZOOLOGY SECTION III

RAY JORDAN, Chairman

Ultrastructure of the Protozoan *Ambiphrya ameura*. MALINDA E. FITZGERALD AND LEWIS B. COONS, Memphis State University.

Ambiphrya ameura is a ciliated peritrich found attached to

the gill tissue of warm water fishes. These protozoans are filter feeders on bacteria in water that passes over the gills. With the aid of scanning electron microscopy, the ultrastructure of this protozoan and its attachment to the gills were investigated.

Ambiphrya has a distinct band of cilia around its mid-region, a band nucleus, and a large ciliated peristomal region. At low densities *Ambiphrya* has no apparent harmful effect on the fish. However, densities may develop such that large areas of gill tissue are covered, possibly impeding respiration. Ultrastructural studies did not reveal any evidence of this organism receiving nourishment from the host tissues.

Preliminary report of the Eosentomidae (Protura-Insecta) of Tennessee. T. P. COPELAND, East Tennessee State University.

These species were collected along with sixteen forms which are being described as new species: *Eosentomon dureyi* Copeland, *Eosentomon wheeleria* Silvestri, *Eosentomon pseudoweeleri* Copeland, *Eosentomon tennesseenses* Copeland, *Eosentomon vermiforme* Ewing, *Eosentomon rostratum* Ewing, *Eosentomon montanum* Copeland, *Eosentomon pallidum* Ewing, *Eosentomon quadridentatum* Copeland, *Eosentomon pseudoyosemitense* White-Copeland.

Leg Abnormalities Associated With The Haplo-4, *ci^w* Genotype in *Drosophila melanogaster*. D. B. BENNER, East Tennessee State University.

The fourth chromosome mutant cubitus interruptus-Wallace (*ci^w*) is named for its effect on the cubital wing vein. Stern (Science 108: 615, 1948) reports that in addition to the effect on the wing there is a crippling effect and enlargement of leg joints when *ci^w* is heterozygous with a deficiency. This report describes more severe phenotype modifications produced by the haplo-4, *ci^w* condition. The legs show gross developmental abnormalities including the presence of extra bristles, the enlargement of tarsal segments, and incomplete formation of the intersegmental membrane. These have an appearance similar to those produced by mutants which Postlethwait and Schneiderman (Annual Rev. Genetics, vol. 7, 1974) class as "affecting position and polarity within a segment". The presence of extra bristles suggests that one effect of the mutant is excess cell proliferation.

Laboratory Investigations of Migration in *Drosophila*. ROBERT CHAMBERLIN AND CHARLES J. BIGGERS, Memphis, State University.

Insect migration has held considerable interest for many as evidenced by extensive research in the area. The study reported here focuses on migration of *Drosophila* under controlled conditions. The objective of the study was to determine if the migration of *Drosophila* is random.

Six bottles (225 ml each) were connected by plastic tubing (1/4" internal diameter), and 50 *Drosophila melanogaster* were placed in a centrally located bottle. Two of the bottles had previously contained 50 flies each for three days. The migration was not random but directed toward the cleared bottles as evidenced by a chi-square analysis.

Additional studies consisted of repeating the above experiment using *Drosophila virilis*. Preliminary data implies non-random movement in this species.

Finally, three bottles were connected to a central bottle containing 50 *D. melanogaster*. One of the outer bottles previously contained 25 adult males, another had contained 25 adult virgin females, and one contained 25 larvae. Migratory behavior here appeared to be directed toward the cleared male and female bottles.

A Study of the Tardigrada from a Farm in Montgomery County, Tennessee. MARTHA E. HUNTER AND DIANE I. FINDLEY, Austin Peay State University.

An investigation of the Tardigrada of two select stands of trees in Montgomery County, Tennessee, was conducted to determine the species of tardigrades present, their population sizes, and their distribution. Eight species of tardigrades, representing five genera, were identified from the epiphytes on the bark of *Juniperus virginiana* and *Cornus florida*. A comparison was made of the tardigrade fauna inhabiting mixed samples of mosses, lichens, and liverworts on these trees.

An Aquatic Tardigrade, *Isohypsibius Augusti*, from the Ocoee River, Copperhill, Tennessee. DIANE R. NELSON, East Tennessee State University AND DEEDEE KATHMAN, Tennessee Technological University.

In December 1976, a two-year study of several rivers and lakes in the Copperhill Basin, Tennessee, was initiated to evaluate ecological accommodation to pollution abatement systems incorporated into Cities Service's discharge into the Ocoee River drainage. Samples taken by Ponar, Surber and artificial substrate techniques were employed in an effort to analyze benthic population dynamics throughout the drainage basin. Tardigrades were found on the artificial substrate sampler (the Kathman sampler) at one site in the Ocoee River. A large population of the aquatic species, *Isohypsiobius augusti*, was collected in January 1977, just below a sewage outflow, representing a new distribution record for this species. Females with eggs, molting individuals, and tardigrades with a fungal infection were photographed with an ETEC scanning electron microscope.

Water Mites (Genus Arrenurus) of Tennessee. JAMES L. WILSON, University of Tennessee at Nashville.

A brief resume of water mite taxonomy and methods of collecting and preserving is given. A preliminary list of water mites of three subgenera (*Arrenurus*, *Megaluracarus*, *Micruracarus*) of the genus *Arrenurus* from Tennessee is presented. The list includes several new records for Tennessee. Recent work on Tennessee collections indicates several new species which will be discussed.

Verticle Zonation of Benthic Macroinvertebrates in Two Shallow Lakes. J. P. SWIGERT, AND E. L. MORGAN, Tennessee Technological University, AND D. L. STONEBURNER, National Park Service, Southeast Region.

The benthic macroinvertebrate fauna was investigated at two shallow lakes on the Carl Sandburg Home, National Historical Site, Flat Rock, North Carolina. A K-B core sampler was employed to remove sediment cores of 40 centimeters in length and four centimeters in diameter. The cylinder was frozen and subsequently sectioned into increments of four centimeters. Benthic macroinvertebrate communities were separated, identified, and enumerated for each four centimeter core section. The phenomena of vertical zonation is discussed in light of sediment particle size distribution and habitat availability according to community structure and function.

Water Quality Monitoring Using an Automated Biomonitor and NASA's GOES Satellite. K. W. EAGLESON, AND E. L. MORGAN, Tennessee Technological University, AND N. MCCOLLOUGH, The University of Tennessee.

Generally, the lag-time inherent in field biological monitoring programs exceeds the reaction-decision process. A need is seen then for remotely sensing the biological impact of complex interacting factors encountered in a multiple use water resource. A biological monitor has been developed using fish breathing rates as a measure of biological response to physical/chemical water quality changes. These changes alter the expected breathing rates and are used in interpreting complex water quality fluctuations. A remote capacity is necessary if an effective regional monitoring network is to be established. This requirement was met by using NASA's GOES satellite for data transmission. Simultaneous chemical/physical data is provided by the National Park Service using similar satellite data transmission. Data is then statistically tested for correlations between physical/chemical fluctuations and biological responses. The system is seen as having potential for wilderness monitoring, identification of regional nonpoint source run-off pollutants, and watershed management.

Preliminary Study of Brain to Body Weight Ratio in Three Genera of Family Plethodontidae. D. I. PAV AND R. J. COWIE, East Tennessee State University.

There is virtually no anatomical information in the literature on the nervous system in salamander groups living in eastern Tennessee. From the large number of genera and their varied degree of adaptation for terrestrial life, three salamander species in the Family Plethodontidae were chosen for a comparison of relative brain to body weight ratio: *Leurognathus marmoratus*, almost totally aquatic, living in mountain brooks; *Desmognathus fuscus*, showing intermediate aquatic requirements; and *Plethodon glutinosus*, a species strictly terrestrial with no aquatic larval forms. The results show a pattern of increased relative brain

weight as correlated with aquatic, semiaquatic and terrestrial habitat.

Preliminary Comments on the Distribution and Ecology of Desmognathus Aeneus in Tennessee. R. L. JONES, The University of Tennessee.

Two species of small, terrestrial salamanders of the genus *Desmognathus* occur in Tennessee. The range and biology of *D. wrightii*, the pygmy salamander, are well known. The seepage salamander, *D. aeneus*, has been reported previously from one locality in Polk County. Preliminary investigations indicate that *D. aeneus* ranges throughout the Unicoi Mountains of eastern Polk and Monroe Counties. Habitat and diel activity in Tennessee closely resemble published descriptions of these characteristics in other parts of the range. The nature and location of its habitat indicate that *D. aeneus* may warrant management status.

Preliminary Comments on the Distribution and Ecology of Desmognathus Welteri (Black Mountain Dusky Salamander) in Tennessee. W. H. REDMOND AND R. L. JONES, The University of Tennessee.

Field investigations during the summer and fall of 1977 indicate the range of *Desmognathus welteri* is more extensive in Tennessee than previously reported. The species was found to be a common inhabitant of small upland streams in the northern half of the Cumberland Plateau Physiographic Province. Preferred habitats appear to be small to medium-size upland streams with rock and gravel substrates. Specimens were collected from elevations ranging from 1,000 to 2,640 feet.

Alteration of streams by coal strip mine runoff and the extensive use of the species by bait fishermen have resulted in the decline of some local populations. However, it is concluded that the overall well-being of the species in Tennessee is not threatened.

Recent Development and Application in Automated Biological Monitoring. E. L. MORGAN AND K. W. EAGLESON, Tennessee Technological University AND N. D. MCCOLLOUGH, Jr., University of Tennessee.

Pressing needs to meet national goals for maintaining environmental quality have stimulated recent developments and applications in automated biological monitoring. Over the past decade these systems were designed for use in monitoring industrial waste water spills and to conceivably reduce lag-times inherent in routine biological assessments. However, such applications employing fish breathing and movement patterns have been limited due to the highly technical nature and prohibitive costs of such automated systems.

Availability to microprocessors and microcircuitry techniques have provided new dimensions in automated biomonitoring with improved capabilities and cost reductions. Present applications in industrial biomonitoring, remote biological sensing and satellite retrieval systems and other recent developments in aquatic ecology are discussed.

Research support has been provided by USDI, OWRT; Cities Services Company; USDI, National Parks Service; Aquatic Ecology Fund, Tennessee Technological University.

COLLEGIATE DIVISION

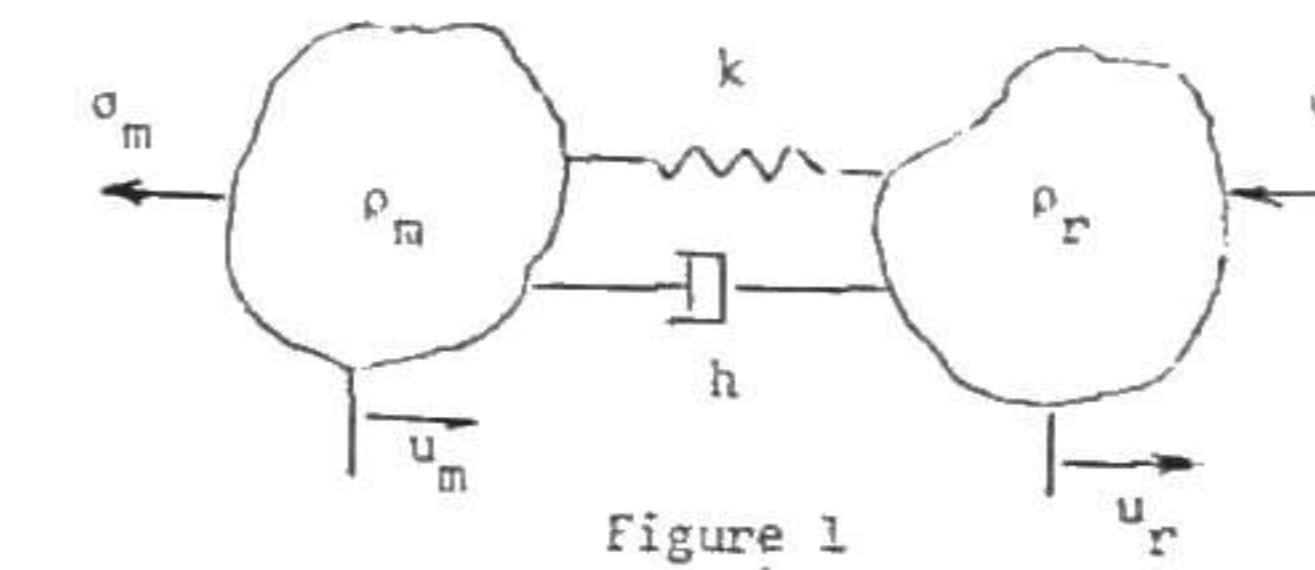
RICHARD J. RARIDON, *Chairman*

Effects of Thermal Stress on Predator-Prey Relationships. VICTOR VAN CLEAVE AND RANDY H. CATE, The University of Tennessee at Martin.

Previous research indicates that thermal stress alters many predator-prey relationships. Experiments were designed to determine both the impact of thermal stress on a common predator-prey relationship and possible factors influencing that relationship. The golden shiner, *Notemigonus crysoleucas*, was used as prey and the large-mouth bass, *Micropterus salmoides*, was used as predator. The shiners were marked for identification by clipping small segments from the caudal fin. The temperatures used for the different trials were 28, 29, 30, 31, and 32°C. After a stress period of thirty minutes, an equal number of stressed and unstressed shiners was introduced to the bass in a ten gallon tank for thirty minutes. Feeding behavior was observed and the number of prey remaining after the thirty minute predation

period was recorded. Pooled data shows a preference for stressed prey at the 99% level (Chi-square). Further studies are in progress using artificial prey to determine why stressed prey are preferred.

The Summation of Higher Order Hyperbolic and Trigonometric Series. FREDERIC C. STEVENS AND WILLIAM JONES, Tennessee Technological University.



The equations of motion for the matrix and reinforcing are, respectively,

$$m \ddot{u}_m + h(\dot{u}_m - \dot{u}_r) + k(u_m - u_r) = F_m \quad (1)$$

$$r \ddot{u}_r + h(\dot{u}_r - \dot{u}_m) + k(u_r - u_m) = F_r \quad (2)$$

The terms on the right-hand side represent the coupling between velocities and displacements.

The constitutive equation for the matrix is characterized by Figure 2 and leads to the equation

$$m \ddot{u}_m + h(\dot{u}_m - \dot{u}_r) + k(u_m - u_r) = 0 \quad (3)$$

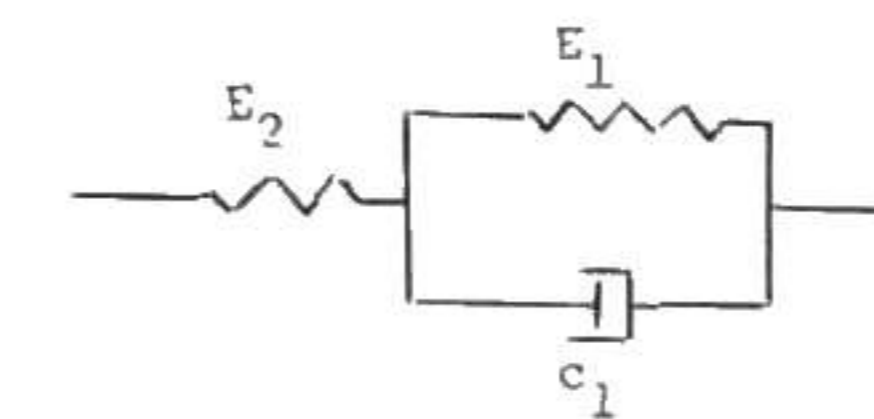


Figure 2

The Mississippian Bangor Formation Near Hales town, Tennessee—Part of a Tidal Flat Complex? WAYNE WILLIAMS AND RICHARD E. BERGENBACK, The University of Tennessee at Chattanooga.

A roadcut exposure of the Mississippian Bangor Formation, located adjacent to I-24 near Hales town, Tennessee, was examined for bed morphology, large- and small-scale sedimentary structures as well as texture and composition. Probable mud flat, tidal channel fill, barrier and subtidal argillaceous calcarenite environments were recognized. Presumably, these environments represent a small part of an extensive tidal flat complex.

A Short Study of the March Periwinkle, Littorina irrorata. P. DENNIS GIBSON, STEVEN H. THOMPSON, AND KRISTIL K. KIMBRO, The University of Tennessee at Nashville.

Population studies of the marsh periwinkle, *Littorina irrorata*, were conducted on the grounds of the Gulf Coastal Research Laboratory, Ocean Springs, Mississippi. The greatest density of snails was found to be at the junction of the *Juncus* and *Spartina* communities. Movements of the snails were found to be both horizontal and vertical in response to tidal changes.

Tradescantia Stamen Hairs as a Test System for Mutation Studies. MARCIA THOMAS AND P. S. KAHLON, Tennessee State University.

Tradescantia clone 4430 originated as an interspecific cross between *T. hirsutum* and *T. subcaulis* was used as a test system. This clone is heterozygous for blue color and change or deletion of one allele results in change in color from dominant blue to recessive pink.

Tradescantia clones in potted plants are acclimatized in the growth chambers for 10 days; and then cuttings from these plants are immersed in sodium azide solution for various lengths of time. After the treatment, the immersed end of the cutting is washed in sodium thiosulfate solution to remove unreacted mutagen.

The flowers from these cuttings were analyzed for pink cells, unpigmented cells, giant cells and dwarf cells in the stamen

hairs. The pink or colorless sectors in the petals were also recorded.

(Supported by CSRS grant no. TENX-PR-0007-35884)
The Effect of Lead and Cadmium Uptake on Euglena. GARY MITCHELL AND JAMES A. CAMPBELL, Tennessee State University.

Euglena were cloned and cultured in microcosms housed in 250 ml Erlenmeyer flask and maintained in an environmental chamber at 70° ± 2 F. Twelve cultures were used, five of which were inoculated with lead solution that when infused in the medium made lead concentrations of 1, 5, 10, 15 and 20 ppm respectively. Of the seven remaining cultures, five were infused with cadmium producing concentrations of 1, 5, 10, 15 and 20 ppm respectively. The remaining two cultures were used as controls. Three replicas were used for each concentration level. Both lead and cadmium had adverse effects on *Euglena* populations. The most significant one occurred in concentrations 15 and 20 ppm respectively. The least effect was exhibited in cultures containing 1 ppm lead and cadmium. The growth pattern of *Euglena* in cultures containing 1 ppm cadmium and lead was similar to that of the controls. Whereas both lead and cadmium adversely affected populations, the effect of cadmium was more immediate. After four days of post-inoculation the lethality of *Euglena* grown in cadmium containing medium was evident, but in the case of lead, it was as long as twelve days before its effects were evident.

The Uptake of Lead and Cadmium by Chlamydomonas Reinhardii. MICHAEL E. REYNOLDS AND JAMES A. CAMPBELL, Tennessee State University.

The purpose of this investigation was to determine the rate and quantity of uptake of the metals cadmium and lead by *Chlamydomonas reinhardii* and also the effect these metals had on the mortality and reproduction of the algae. *Chlamydomonas* cultures, housed in 250 ml Erlenmeyer flask and maintained in an environmental growth chamber were inoculated with lead and cadmium. The algae were observed daily for four days during which cell counts and density readings were taken. The Aztec Atomic Analyzer was used to determine the uptake of lead and cadmium. Based on preliminary data *Chlamydomonas reinhardii* utilized cadmium much more readily than lead as was determined by population count and chemical analysis.

Explanation of the Formation of Crossbedded Festoon Deposits in Pennsylvanian Sandstones. EDWARD ROBBS AND RICHARD E. BERGENBACK, The University of Tennessee at Chattanooga.

Bedforms, considered here as festoon deposits, may be found in sandstones and conglomerates which belong to the Pennsylvanian Gizzard Group and Crab Orchard Mountains Group on the Cumberland Plateau. Festoons may be recognized by their curved-concave upward, base which presumably represents the trough portion of megaripples or dunes. The "size" of these troughs may range from less than one foot to tens of feet. It is the concern of this study to learn more about the process of filling of troughs, or festoons, by crossbedded sandstone. This may be accomplished by making very careful field observation of the morphology of crossbedded bedforms as well as textural distribution of clastic particles within an individual bedform. These data are then interpreted in the light of laboratory studies of delta front sedimentation by A. V. Jopling.

Typical Fauna of a Florida Coral Reef. DAVID BARNETT, Belmont College.

This audio-visual presentation is composed of a series of slides taken on a recent trip to the Florida Keys. Representative species are shown from the phylum Echinodermata, the classes Osteichthyes and Elasmobranchii of the phylum Chordata, and the class Anthozoa of the phylum Coelenterata.

On the Occurrence of Odd Perfect Numbers. W. K. PITTS, Austin Peay State University.

Perfect numbers are those numbers whose factors add up to the number. All perfect numbers found are even; odd numbers are shown to be of a form that prohibits them being perfect if certain powers of prime integers are contained in the number.